

Windmill Worksheet [From the *NOVA* Web site]

Teacher Notes

Part of what students are doing in this activity is reverse engineering, in which students look at something that exists to figure out how it works rather than building from the ground up. On the Windmill Template (Figure A), the solid lines indicate where to cut the paper and the dotted lines indicate where to fold (but not crease) it. The circles indicate where to punch holes. Figure B shows how the corners of the windmill are folded over and attached to the straw and how the rubber bands are used to keep the windmill in place. Figure C shows the cup and string attachment, and Figure D shows how to hold the machine so that the straw spins freely as the windmill turns. Students will discover through trial and error how best to attach the string to the straw. Because there is no exact description of materials, student choices may vary. For example, one team may choose regular bond paper for the windmill while another may choose a card stock. This provides a good opportunity to discuss how different materials behave within the design and why.

Students familiar with pinwheels will know that blowing on the windmill causes it to turn. Students may then use this information to help them understand how wheel-and-axle machines work. If students are not familiar with this type of simple machine, you may want to identify it at the activity's end.

At the end of the activity, students may experiment by changing the size of the windmill, the type of paper used for the windmill, the diameter of the straw, or even substituting entirely new materials.

Materials

Per windmill:

- Windmill Template, two different sizes (Figure A, downloadable from the lesson plan) The templates can also be scaled up to make larger windmills.
- sheet of paper, 8 1/2 in. x 11 in. (22 cm x 28 cm)
- pencil or single hole punch
- 2 rubber bands
- scissors
- straw
- small paper cup
- piece of string, 20 in. (51 cm)

Machine Assembly Instructions

1. Using one of the templates provided, draw your pattern on a sheet of paper. Transfer all of the pattern's lines and circles.
2. Use a pencil or single hole punch to punch a hole through the center circle (you may need to fold the pattern in half to use the single hole punch). Then punch a hole in each corner circle.
3. Cut along the solid lines, making sure not to cut the center hole.



(Figure A)

4. Insert a straw through the center hole.
5. Fold each corner along the dotted line and insert the straw through each corner hole. Slide the windmill to the center of the straw.



(Figure B)

6. Wrap a rubber band around the straw on each side of the windmill to keep the windmill in place.
7. Punch two holes on either side of a small paper cup. Thread one end of the string through both holes and tie it to the middle of the string. Tie the other end of the string to one end of the straw.



(Figure C)

8. Hold the straw with both hands as shown. Blow on the windmill. As the windmill turns, the straw rotates, winding the string and lifting the cup. For a good working design, you need to make sure that the windmill and straw move as a unit and that the string doesn't slip as the straw rotates.



(Figure D)