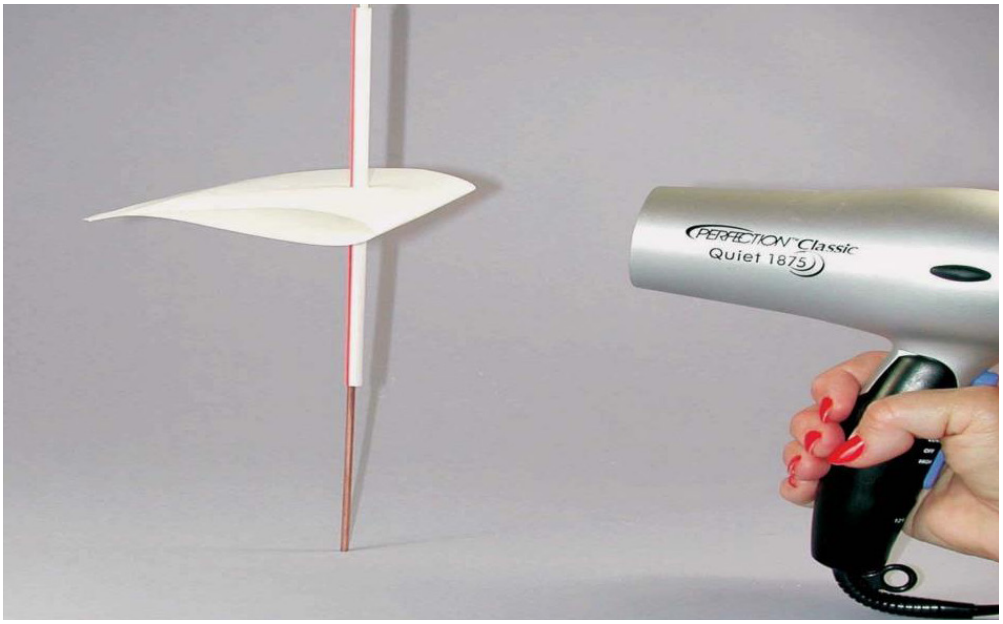
BERNOULLI BASICS
WING ON A STICK

OBJECTIVE – Students will observe/create an airfoil (wing) that flies with the power of a hair dryer.



NATIONAL STANDARDS –
Next Generation Science Standards (https://www.nextgenscience.org/):
Disciplinary Core Idea Progressions
Physical Science Progression
- ES PS2.A: Forces and Motion
- ES PS3.C: Relationship between energy and forces

Crosscutting Concepts
- Systems and system models
- Structure and function

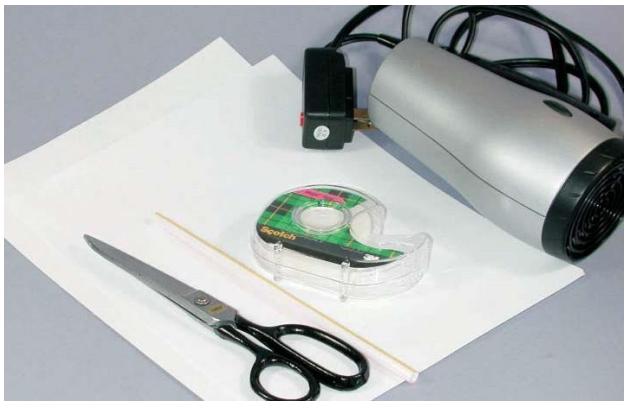
Science and Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
6. Constructing explanations (for science) and designing solutions (for engineering)

Bernoulli Basics Demonstration #1

BACKGROUND - Daniel Bernoulli gave us a principle that is used to explain how a wing flies. However, it was the Wright Brothers' wind tunnel that proved invaluable for gathering important, accurate lift data. The brothers built a device that would provide a steady air flow to test small wing shapes. A number of designs were tested and the best tunnel developed airfoil shape was used in actual flight tests at Kitty Hawk, North Carolina. From that time on, aerodynamicists have been testing various airfoil shapes to determine lifting capabilities and drag coefficients.

MATERIALS

- **a.** piece of paper such as card stock
- **b.** sturdy straw
- **c.** Scotch™ tape
- **d.** Super Glue or hot glue
- **e.** "Vertical Axis" such as string, fishing line, welding rod, piano wire, etc. This is the piece the airfoil will slide up and down upon.
- **f.** Hair dryer (cool setting) or fan



PROCEDURE

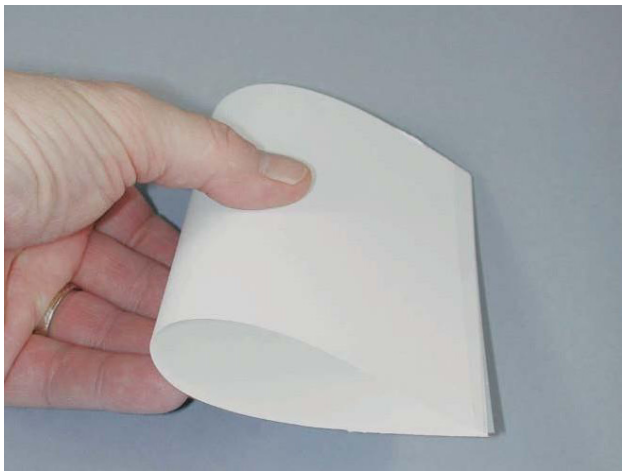
1. To make the airfoil, use about ½ of a sheet of card stock.

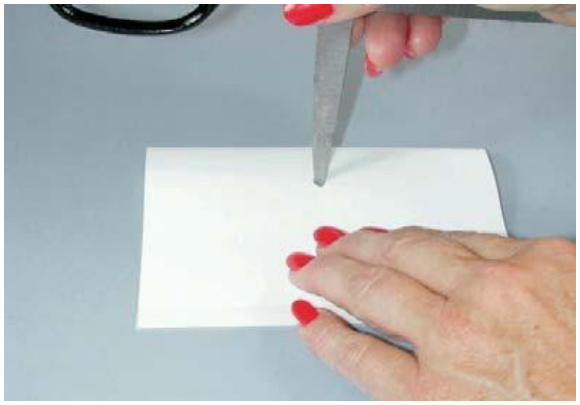
2. Fold the paper so that the chord (a line from the front to the rear of a wing) is about 4 inches long. Tape the trailing edge together with Scotch tape.

3. Do not crease the leading edge. Create a gentle curve for both the top and bottom. A view from the side is seen below.

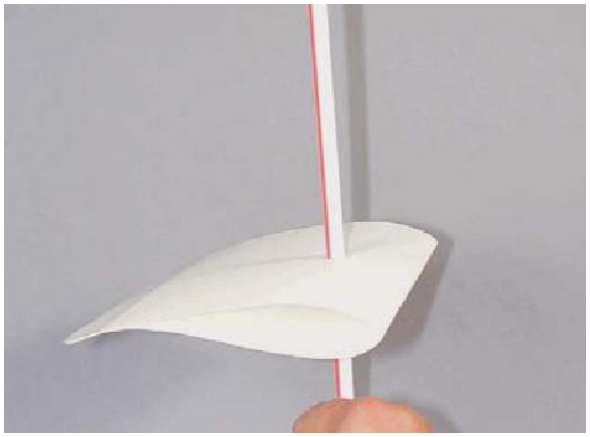
4. At the point of maximum curvature in the airfoil shape, mount a straw by punching a hole with a sharp pencil or pen. Spend some time shaping the airfoil so that the leading edge (closest to the hand in this photo) is gently rounded.

Fold Card stock as shown here





Scissors or a hobby knife can be used to cut a hole in the upper and lower curved surface (called the camber).



5. Repeat step 4 on the bottom side. This will allow the straw to slide through the wing at exactly 90 degrees to its chord.

6. A little hot glue will hold the straw in place. “Super Glue” can also be used to bond the straw to the wing. Be aware that super glue can bond fingers together. If you plan to use this activity with students, and you are using super glue, use extra caution.

7. Next, cut the straw so that only about 4 inches stick out on the top and bottom. This may even be trimmed down to about 2 inches on each side.

8. Set up a rod so that the airfoil can be mounted. It's ready to fly!

9. When you get everything together, and the wing is ready, provide a source of wind and watch it climb the rod.

10. If the wing wants to go round and round, you might add a”rudder” by taping a piece of card stock to the back, or trailing edge.

11. Experiment with it until you make the wing rise right up the line. This will fascinate students and then, of course, everyone will want to make a wing of their own design!

This is a picture of a Civil Air Patrol Cessna. It clearly shows the shape of a wing. Notice how it is curved on the top. This is what gives the wing most of its lifting capability.