

# Air and Lift - The Bernoulli Effect

Ever wonder what helps an airplane fly? Airplanes use the air moving over their wings to help give them lift. This is called the Bernoulli effect. Here are some experiments to help you discover how air gives "lift."

This is a series of 3 experiments, scroll down to see the instructions for each one!

## Materials

Paper  
Scissors  
Transparent tape  
Sharp pencil  
Drinking straw  
Thread or very thin string  
Tape  
Ping-pong balls  
Ruler  
Hairdryer

# Experiment #1: Flying Paper Strips

1. Using the ruler, measure and cut-out strips of paper about 2 inches wide and 6 inches long
2. Hold the shortest end just under your mouth, and blow over the paper.
3. What happened? What do you think will happen if you change the size of the paper?
4. Do you think the shape of the strip of paper is important? Try experimenting!
5. Do you think the experiment will always work?

# Experiment #2: The Swinging Ping-Pong Balls

1. Use the ruler and measure and cut two thin pieces of string 12 inches long.
2. Take a piece of string and tape one end of the string to a Ping-Pong ball.
3. Tape the other end of the string to the ruler.
4. Take the other piece of string and another ping-pong ball and repeat steps 2 and 3.
5. The Ping-Pong balls should be hanging about 1 inch apart on the ruler. Hold the ruler up so that the balls hang freely.
6. What do you think will happen if you blow in between the two balls? Try it! What did you see happen?

# Experiment #3: Wing on a String

1. Print out the wing template (located on the next page).
2. Cut out the wing's shape along the dark solid line.
3. Fold along the dotted line. One half is 1/2 inch shorter than the other.
4. Tape the SIDE A to SIDE B so that the bottom side is flat and the top is curved like an arch.
5. Use a pencil to make a hole where the black dot is, and poke straight through the other side of the wing, so that the pencil can slide in one end and out the other.
6. Push a straw through the hole and attach it to the top and bottom of the wing with two small pieces of tape.
7. Cut the straw so as little of the straw is above or below the string as possible.
8. Feed some thread through the straw and tie the end that is on the flat side of the wing (SIDE B) to a paperclip.
9. Tie the end of the string with the paper clip to the arm of a chair or another secure spot.
10. Hold the other end of the string in the air so that the string is up tight and pointing up and down.
11. Think about the first two experiments....What do you think will happen if you blow air on the wing? Use a hairdryer to blow air on the wing and see what happens.
12. Experiment with the hairdryer and the wing to see if you can change what happens

Side A



Side B

# How and why does this work?

Most people think the paper should go down as you blow across the top but the paper actually rises up! This is because the air you blow is moving faster than the air under the paper. That means there is more pressure underneath the paper than on top.

The same thing happens with the ping-pong balls. When you blow in between the two balls, the fast moving air helps pull the balls closer together. The air traveling over the curved surfaces of the balls is faster and therefore has less pressure than the air on the outside of the balls. Both balls move to where there is less pressure, so they move towards the middle and get closer together. The air pressure on the outsides does not increase, but the pressure in the middle decreased, making the balls swing towards each other. The balls were not "sucked" together. They were pushed together.

The curved surface of the wing causes the air to move faster over the top of the wing than the bottom. The faster moving air has less pressure than the slower moving air on the bottom of the wing. The greater pressure underneath pushes the wing upwards.

This effect is called the "Bernoulli principle" after Daniel Bernoulli, a Swiss mathematician who lived in the mid 1700's. Bernoulli never really thought about flying. He was more interested in learning what causes changes in pressure. He died one year before the first balloon flight in 1783 and 71 years before the first winged glider flight in 1853.