# HOW DOES AN AIRCRAFT FLY?

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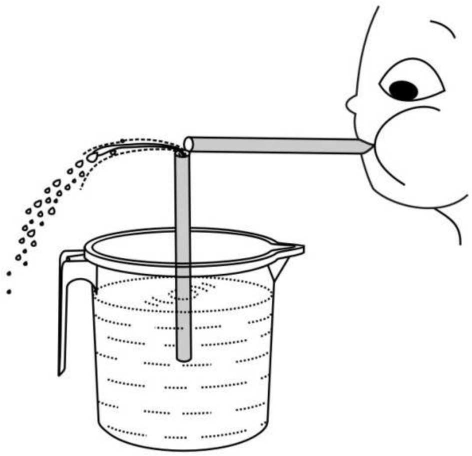
A modern airliner weighs hundreds of tons. How does such a heavy object manage to keep flying at 30,000 feet above the ground? Why doesn't it fall like a stone?

The key to its understanding lies in the humble spray gun.



Take an ordinary straw and make a half cut at a distance of one-third from one end. Bend the straw at right angles and place it in a glass of water. Dip the short end in water and blow from the long end. A spray of water will come out from the joint. Why?

As you blow through one end of the straw, the high speed of the air at the junction lowers the air pressure thus lifting water from the glass which then comes out like a spray.

This phenomenon is called Bernoulli's principle, after the Swiss mathematician Daniel Bernoulli (1700-1782) who was the first to study this phenomenon in 1778, and who invented the term "hydrodynamics."

A very early example of a flying machine using Bernoulli's principles was the kite, which first appeared in China in about 1000 B.C. The kite's design, particularly its use of lightweight fabric stretched over two crossed strips of very light wood, made it well-suited for flight, but what kept it in the air was a difference in air pressure. At the best possible angle of attack, the kite experienced an ideal ratio of pressure from the slower-moving air below versus the faster-moving air above, and this gave it lift.

There are several other interesting illustrations of Bernoulli's principle —some are fun but a few are also potentially tragic. For instance, once the shower is turned on the shower curtain billows inward. Logically the water flow should push the curtain outward, securing it to the side of the bathtub. Instead, the fast-moving air generated by the flow of water from the shower creates a center of lower pressure, and this causes the curtain to move away from the slower-moving air outside.

Bernoulli's principle creates results that, on first glance at least, seem counterintuitive—that is, the opposite of what common sense would dictate.

Another fascinating illustration involves placing two empty soft drink cans parallel to one another on a table, with a few centimeters between them. At that point, the air on all sides has the same slow speed. If you were to blow directly between the cans, however, this would create an area of low pressure between them. As a result, the cans push together and collide.

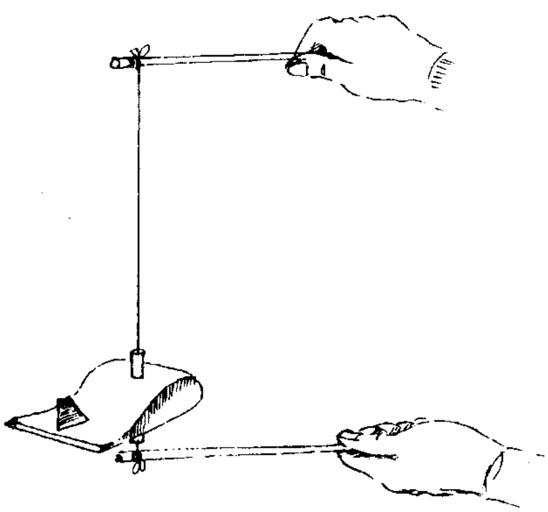
For ships in a harbor, this can be a frightening prospect: hence, if two ships are parallel to one another and a strong wind blows between them, there is a possibility that they may behave like the cans and collide.

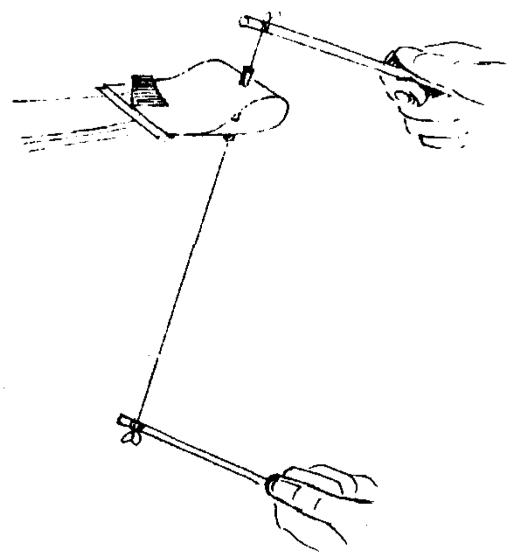
On railway platforms there is usually a yellow line. Passengers are supposed to stand behind it while waiting for the train. This is because the fast air velocity close to the moving train body can produce enough low pressure to drag you towards the train.

## Airplane Wing

The airplane wing is shaped like an aerofoil. Its top is curved and the bottom is relatively flat. So the air traveling over the top of the wing needs to travel faster than the air going along the bottom. The higher velocity of air on the top leads to a drop in pressure thus providing "lift" from below.

Bend a 20 x 10 cm piece of rectangular paper in half and stick the edges together. Shape the wing such that it is curved at the top and flat below. Make a hole about 3-cm from the leading edge and glue a piece of straw. Stick a paper fin on the trailing edge. Pass a thin thread through the straw and attach two sticks on the end. As you swing the sticks through the air the wing will rise on the thread.

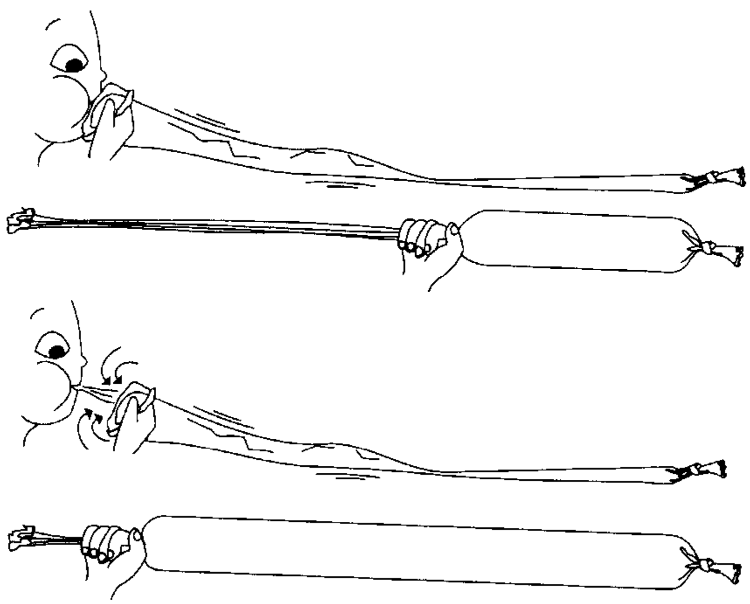




## Bernoulli's Bag

Take a plastic tube (10-cm wide) and 2 meters long. Tie a knot at one end of this flexi-tube. Hold the tube next to your mouth. Take one deep breath and blow it into the tube. Only the air from your mouth will enter the tube which will be a measure of your lung capacity – approximately 3-liters.

Next keep the tube end 15-cm away from your mouth. Again take a deep breath and blow one full breath. You might think that less air will get in. But the opposite happens. This time much more air gets inside the tube. The high velocity of the blown air creates a low pressure zone, sucking a lot of air from the outside.



A final illustration of Bernoulli's often counterintuitive principle neatly sums up its effects on the behavior of objects. For this you need only an index card and a flat surface. Fold the ends of the index card about 1-cm from the ends to make a low height table.

Now invite a friend - someone who has not studied Bernoulli's principle—on the scene, and challenge him to raise the card by blowing under it. Nothing could seem easier, of course: by blowing under the card, any person would naturally assume, the air will lift it. But of course this is completely wrong according to Bernoulli's principle. Blowing under the card, as illustrated, will create an area of high velocity and low pressure. This will do nothing to lift the card: in fact, it only pushes the card more firmly down on the table.