Flying Machines Game Plan

eCamp Flight Lab

Objective You're going to do several experiments that change air pressure and mystify your kids. The goal is to set them thinking about how and why things fly (you'll do this by learning about air pressure and Bernoulli's law, but you don't need to tell them that). The first thing to do is watch the video on the *Flying Machines* website page, and then dive into the experiments.

Main Ideas While the kids are playing with the experiments see if you can get them to notice these important ideas. When they can explain these concepts back to you (in their own words or with demonstrations), you'll know that they've mastered the lesson.

1. Air pressure is all around us. Air pushes downward and creates pressure on all things.
2. Air pressure changes all the time.
3. Higher pressure always pushes.
4. The faster air travels over a surface, the less time it has to push down on that surface and create pressure. Fast moving air creates low pressure regions. (Bernoulli's Law).
5. The four fundamental forces on an airplane are lift, weight, thrust, and drag.

About the Experiments There are a lot of experiments in this section that will hone your child's observation skills. About half the experiments are on flying machines and the other half consist of air pressure demonstrations. When their airplane doesn't work right, ask them what exactly it's doing (or not doing), and then take a more careful look at how it's constructed. Focus on watching what happens when you make small changes, and try to change only one thing at a time.

The *How* and *Why* Explanation There's air surrounding us everywhere, all at the same pressure of 14.7 pounds per square inch (psi). You feel the same force on your skin whether you're on the ceiling or the floor, under the bed or in the shower.

An interesting thing happens when you change a pocket of air pressure – things start to move. This difference in pressure causes movement that creates winds, tornadoes, airplanes to fly, and some of the experiments we're about to do together.

An important thing to remember is that higher pressure always pushes stuff around. While lower pressure does not "pull," we think of higher pressure as a "push". The higher pressure inside a balloon pushes outward and keeps the balloon in a round shape.

Weird stuff happens with fast-moving air particles. When air moves quickly, it doesn't have time to push on a nearby surface, such as an airplane wing. The air just zooms by, barely having time to touch the surface, so not much air weight gets put on the surface. Less weight means

less force on the area. You can think of "pressure" as force on a given area or surface. Therefore, a less or lower pressure region occurs wherever there is fast air movement.

There's a reason airplane wings are rounded on top and flat on the bottom. The rounded top wing surface makes the air rush by faster than if it were flat. When you put your thumb over the end of a gardening hose, the water comes out faster when you decrease the size of the opening. The same thing happens to the air above the wing: the wind rushing by the wing has less space now that the wing is curved, so it zips over the wing faster, and creates a lower pressure area than the air at the bottom of the wing.

The Wright brothers figured how to keep an airplane stable in flight by trying out a new idea, watching it carefully, and changing only one thing at a time to improve it. One of their biggest problems was finding a method for generating enough speed to get off the ground. They also took an airfoil (a fancy word for "airplane wing"), turned it sideways, and rotated it around quickly to produce the first real propeller that could generate an efficient amount of thrust to fly an aircraft. Before the Wright brothers perfected the airfoil, people had been using the same "screw" design created by Archimedes in 250 BC. This twist in the propeller was such a superior design that modern propellers are only 5% more efficient than those created a hundred years ago by the two brilliant Wright brothers.

Questions to Ask When you've worked through most of the experiments ask your kids these questions and see how they do:

1. Higher pressure does which? (a) pushes (b) pulls (c) decreases temperature (d) meows (e) causes winds, storms, and airplanes to fly
2. The tips on the edge of a paper airplane wing provide more lift by: (a) flapping a lot (b) destroying wingtip vortices that kill lift (c) getting stuck in a tree more easily (d) decreasing speed
3. In the ping pong ball and funnel experiment, the ball stayed in the funnel was because: (a) you couldn't blow hard enough (b) you glued it into the funnel (c) the ball had a hole in it (d) the fast blowing caused a low-pressure region around the ball, causing the surrounding atmospheric pressure to be a higher pressure, thus pushing the ball into the funnel
4. In the sneaky bottle experiment, which of the two bottles was the balloon able to inflate in? (a) the one with a hole (b) the one with no holes (c) the one the kid fit inside
5. If your plane takes a nose dive, you should try (a) changing the elevators by pinching the edges (b) change the dihedral angle (c) change how you throw it (d) all of the above
6. What are the four forces that act on every airplane in flight?
7. Draw a quick sketch of your plane viewed from the front with a positive dihedral.
8. Why does the index card stay in place when you invert the cup of water in the magic water glass trick?
9. When the balloon was squished into the jam jar with the snuffed candle, where was the higher pressure?

10. Why does the water stop streaming out of the bottle when you put the cap on in the streaming water experiment? Why does the water come out if you squeeze the capped bottle?
11. How can you make the fountain bottle shoot even higher?
12. If you were designing your own "Flying Paper Machine Kit", what would be inside the box?
13. What's the *one thing* you need to remember about higher pressure?
14. What keep an airplane from falling?
15. Where is the low pressure area on an airplane wing?

Answers:

1 (a, e) 2 (b) 3 (d) 4 (a) 5 (d) 6 (lift, weight, thrust, drag) 8 (15 pounds of air pressure is greater than 0.5 pound of water) 9 (outside the jar) 10 (no incoming air to equalize the pressure, unless you force the water out by squeezing) 11 (get a football player to blow hard) 13 (higher pressure pushes) 14 (lift) 15 (top surface)

