Rocketry Game Plan

eCamp Flight Lab

Objective Kids love going fast and blowing things skyward. This set of experiments should satisfy both needs. The goal is to not only provide them with a safe set of activities that will keep their eyebrows intact, but also to get them *really* excited about aerodynamics and rocket design by building projects that really work. Most rockets will require a certain amount of tweaking (like the *Flying Machines* experiments did) in order to fly straight. This is an excellent time to hone their observation skills and get them into the habit of changing and testing only one thing at a time.

We're going to continue learning about pressure as we generate high pressure through both bicycle pumps as well as chemical reactions. The first thing to do is watch the video on the *Rocketry* 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. For every action, there is an equal and opposite reaction.
2. The position of the center of pressure relative to the center of gravity of a rocket determines how stable the flight will be.

About the Experiments The experiments in this section vary from small indoor flights to rockets that go over a football field in distance. All rockets move by a quick release in pressure. Once your rocket takes flight, take a clear look (or better, a video so you can watch it a few times over) at *how* it flies when it's up there. By launching at an angle instead of straight up, you'll get a better view… just be sure your launch area is clear.

Stability of Flight: A rocket has two key points (CP & CG, covered in the *Flying Machines* experiments) that you need to know in order to have stable flight. Here's how you find and adjust them:

1. *Finding the Center of Pressure:* You can find center of pressure by tying a string around the rocket body and swinging it around your head. The balance point is your center of pressure. Mark the point as CP.
2. *Finding the Center of Gravity:* Balance your rocket on a pencil tip. Mark the point as CG. Note if this is forward or aft of your CP.
3. *To adjust the CG/CP:* It's easier to adjust the CG - add weight to the nose or more fins to the tail section. Re-measure your CG when you're done.

The *How* and *Why* Explanation Rockets shoot skyward with massive amounts of thrust, produced by chemical reaction or air pressure. Scientists create the thrust force by shoving a lot of gas (either air itself, or the gas left over from the combustion of a propellant) out small exit nozzles.

According to the universal laws of motion, for every action, there is equal and opposite reaction. If flames shoot out of the rocket downwards, the rocket itself will soar upwards. It's the same thing if you blow up a balloon and let it go—the air inside the balloon goes to the left, and the balloon zips off to the right (at least, initially, until the balloon neck turns into a thrust-vectored nozzle, but don't be concerned about that just now).

A rocket has a few parts different from an airplane. One of the main differences is the absence of wings. Rockets utilize fins, which help steer the rocket, while airplanes use wings to generate lift. Rocket fins are more like the rudder of an airplane than the wings.

Another difference is the how rockets get their speed. Airplanes generate thrust from a rotating blade, whereas rockets get their movement by squeezing down a high-energy gaseous flow and squeezing it out a tiny exit hole.

If you've ever used a garden hose, you already know how to make the water stream out faster by placing your thumb over the end of the hose. You're decreasing the amount of area the water has to exit the hose, but there's still the same amount of water flowing out, so the water compensates by increasing its velocity. This is the secret to converging rocket nozzles—squeeze the flow down and out a small exit hole to increase velocity.

The rockets we're about to build get their thrust by generating enough pressure and releasing that pressure *very* quickly. You will generate pressure both by pumping and by chemical reaction, which generates gaseous products. Let's get started!

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

1. If you inflate a balloon (don't tie the end), which direction does the air in the balloon and the balloon itself travel? (a) both the same way (b) in opposite directions (c) nothing happens

2. When you drop an effervescent tablet into water, what happens? (a) bubbles foam up (b) it burps (c) carbon dioxide gas is released (d) it produces a chemical reaction that can propel a rocket skyward

3. Puff Rockets use which of the following propellants? (a) air pressure (b) chemical reactions (c) both (d) neither

4. The most dangerous parts of the Water Rocket experiment is are: (a) working with high pressure (b) that you've stripped out the threads that normally secure the cap in place, and now it's easier to accidentally release the rocket and shoot someone's eyeballs out (c) reusing the bottles over and over causes fissures and cracks to form in the bottle, increasing the chances of bursting if you don't replace the bottle after every 7-10 launches (d) all of the above and more

5. The most important things to remember when launching water rockets are: (a) safety goggles or face shield (b) 70 psi maximum air pressure (c) always hold the valve-side down when holding the bottle (d) only use soda bottles that are build to hold pressure (e) never water bottles, juice bottles, sports drink bottles, or any others that don't say *psssssst!* when you first open them

6. To get the multi-staging rockets to work correctly, where does the trigger need to be? (a) inside the first balloon (b) on the string (c) in the straw (d) squished between the first balloon and the cup

7. How does a Slingshot Rocket work? Where does the thrust come from?

8. If your Blow Gun Rocket straw rips loose, what can you do to quickly repair it without rebuilding the entire rocket?

Answers:

1 (b) 2 (a, b, c, d) 3 (a) 4 (d) 5 (a, b, c, d, e) 6 (d) 7 (The thrust comes from the rubber bands. The harder you pull, the further the rocket goes when released.) 8 (The blow gun can be easily repaired by simply cutting off the top and rebuilding the nose section with a new straw.)

