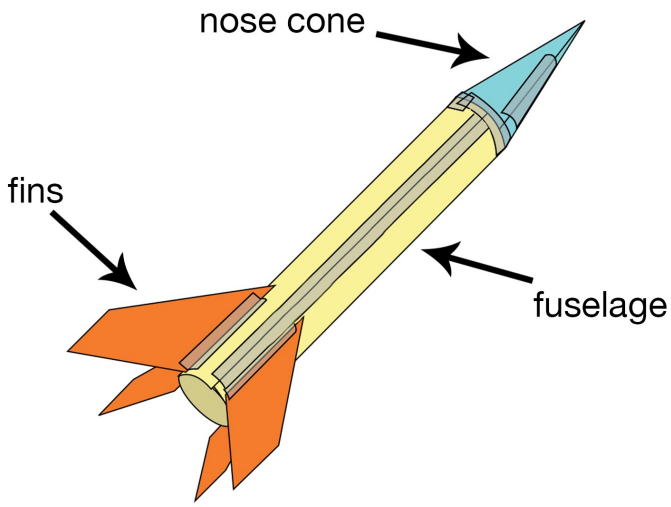
Stomp Rocket Activity Instructions

In Commemoration of the 50th Anniversary of the Apollo 11th Mission, the Louisiana Space Grant Consortium (LaSPACE) invites you to celebrate the mission that resulted in the first moon landing. Apollo 11 launched from Cape Kennedy on July 16, 1969 at 9:32 AM EDT, carrying Commander Neil Armstrong, Command Module Pilot Michael Collins, and Lunar Module Pilot Edwin "Buzz" Aldrin on top of a Saturn V rocket. Before Neil Armstrong could make his "...one small step for a man, one giant leap for mankind," thousands of NASA scientists, engineers, and technicians worked meticulously to craft the vehicle that would get them there. To celebrate this event, LaSPACE has adapted instructions and compiled materials so that Louisiana participants can craft and launch paper rockets from straw and stomp launchers. These instructions were adapted from the NASA's Jet Propulsion laboratory activity "Stomp-Rockets." Don't forget to launch your rocket on July 16th to help break a world record! More info at the website below.



Materials

Assortment of Colored Paper
Cellophane tape
Colors (crayons, markers, pencils)
Scissors
Duct Tape
2-Liter Bottles
PVC Launcher Sections

Objective

Participants will learn about rocket stability as they construct and fly small paper rockets.

Description

In this activity, participants will:

- Work individually or in teams of two to construct and launch paper rockets using an instructor-built PVC pipe launcher.
- Following the flight of their rocket, analyze and modify their design to attempt to increase performance.

Management

Prior to the event, ensure a stomp rocket launcher has been put together for each anticipated participant. Hold on to the launchers until all rockets are ready to be launched. During rocket construction ensure the participants leave the rocket bodies slightly loose so they can move freely along the PVC. During launch, give ample space between launchers, and make sure participants 6 years of age or below are aided by an adult for the duration of the launch.

Presented by U.S. Space & Rocket Center | GLOBAL ROCKET LAUNCH

Join LaSPACE, the U.S. Space & Rocket Center, and the rest of the world by participating in the Global Launch attempt to break the current Guinness World Record by launching your rocket at any time on July 16!

If launching individually, register at https://www.rocketcenter.com/apollo50/GlobalLaunch/Info .

Instruction kit adapted from NASA Jet Propulsion Laboratory's activity "Stomp-Rockets" at https://www.jpl.nasa.gov/edu/teach/activity/stomp-rockets/

Background

Rocket stability is an important issue for rocket scientists. The success of a space launch depends upon "pinpoint" accuracy. If a future NASA Space Launch System rocket arrives in space in the wrong orbit, it may not have enough fuel or supplies to make rendezvousing with the International Space Station or an asteroid possible. The crew would have to return to Earth and "chalk off" a failed mission.

Stability means making sure the rocket follows a smooth path in flight. If it wobbles, the ride will be rough and extra fuel will be burned to get back on course. If it tumbles, it's time to push the destruct button! An unstable rocket is dangerous.

Fortunately, it is relatively easy to ensure stability when traveling through the atmosphere if two things are kept in mind. These two things are center of mass and center of pressure.

Center of mass (COM) is easy to demonstrate. It is the balance point of a rocket. Think of it like balancing a meter stick on an outstretched finger. If the stick rests horizontally, the COM is directly over your finger. If the COM is to the right of your finger, the stick will tip to the right. If to the left of your finger, the stick will tip to the left.

An object, tossed into the air, rotates around its COM. Rockets also try to rotate around their COM while in flight. If this rotation is allowed to happen, the rocket becomes unstable. This is where center of pressure (COP) comes to the rescue.

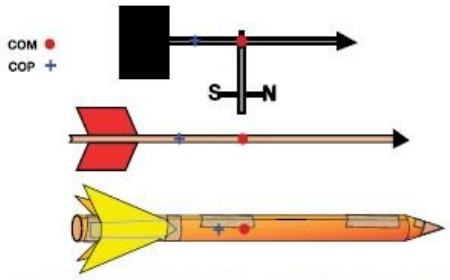
COP is also a balance point. It is the balance point of the pressure exerted on the rocket surface by air molecules striking it as it flies through the air. Like COM, there is a midpoint for the air pressure on the rocket body. This is the COP. For a stable rocket, the COP is located to the rear of the rocket and the COM is to the front. To understand why the rocket is stable, let's take a look at a couple of devices that also depend upon the placement of COM and COP.

A weather vane pivots on a vertical axle (COM) when the wind blows. One end of the vane is pointed and the other end has a broad surface. When the wind blows, the broad end of the vane catches more air (more air pressure) and is blown downwind. The narrow end of the vane has less pressure exerted on it and points into the wind.

One end of an arrow is long, narrow, and pointed while the other end has large feathers (or plastic fins). In flight, greater air pressure is exerted on the feathers than on the narrow end. This keeps the arrow from tumbling around its COM and on course to its target.

In both examples, there was more surface area on one side of the COM than on the other. Both devices were stable. Stability of a rocket is the same thing.

The stomp rockets in this activity, while simple, can have a surprising amount of variability in the altitude they achieve. By eliminating drag and streamlining their designs, participants can make their rockets fly higher. The rockets won't reach the Moon or Mars, but if designed properly, they can reach more than 160 feet!



The positions of center of mass (red dot) and center of pressure (blue +) are shown for a weather vane, arrow, and rocket. The center of pressure is to the rear of the center of mass in each device. This enables them to point into the wind.

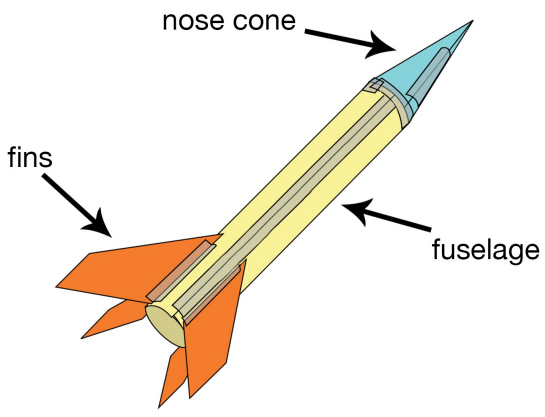
Instructions for Event Participants

Building the Rocket:

1. Roll an 8.5 x 11-inch piece paper snuggly (but not too tightly) around a 24-inch length of 1/2-inch PVC pipe.
2. Tape the paper to itself (avoiding the PVC pipe) with clear tape. Use enough tape to completely seal the seam, making the seam airtight. This will be the body, or fuselage, of your rocket.
3. Slide the fuselage off the PVC form. Verify that the fuselage slips easily from the PVC form so that it will fit on the launch tube later.
4. Once your rocket body is complete, decorate your rocket any way you want using the crayons provided. (If needed, leave it on the PVC form for sturdiness.)
5. Make a nose cone by a) pinching one end of the fuselage, folding it over, and taping it to the rocket body, or b) cutting out a 3/4 circle, rolling it into a cone shape, then taping the seam so that the cone stays in shape (see page 4 for option B).
6. If you chose option B, using scissors, trim the wide end of the nose cone to fit on top of the rocket body and tape in place. Use plenty of tape to make the rocket airtight. (Blow through the rocket from the bottom to check for leaks.)
7. Cut out and decorate fins (of any shape) and attach them symmetrically to the lower part of the fuselage (opposite the nose cone), leaving the opening at the bottom of the fuselage open and clear of tape. The most common shape for fins are triangles (see image below), but feel free to experiment with any shape, size, and number of fins you want.

Launching the Rocket:

1. Gently slide your rocket over the vertical end of the launcher.
2. Once the instructor has given you permission, stomp on the middle of the 2-liter bottle and watch your rocket launch!
3. To launch an additional time, blow down the end of the launcher to fill the 2-liter bottle back up with air.
4. Based on the launch, try building a new rocket or modify your first one to make it fly even higher! Try a different length rocket body, different sized fins, or maybe use more tape to make your rocket more air-tight.



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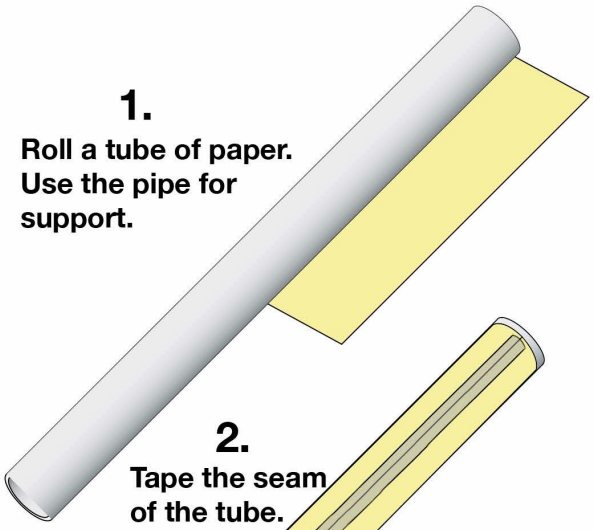
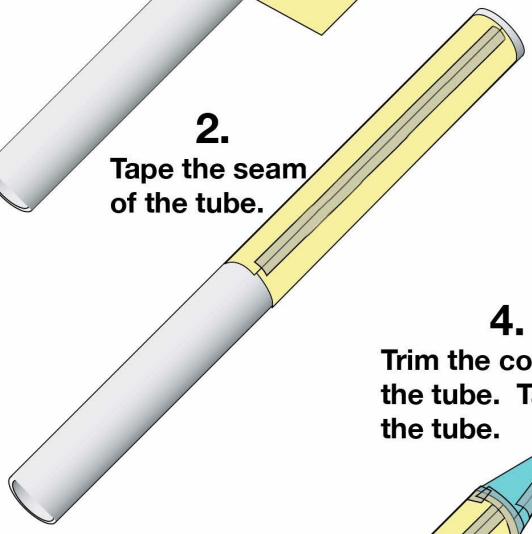
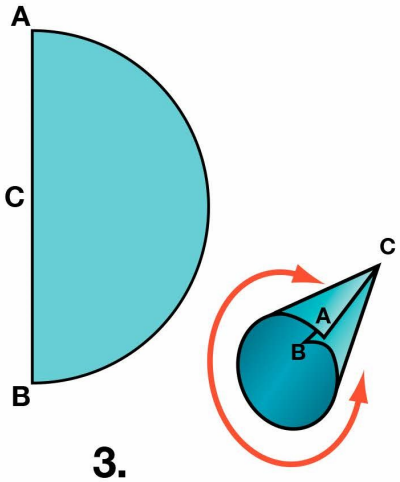
Making a Stomp Rocket



1.
Roll a tube of paper. Use the pipe for support.

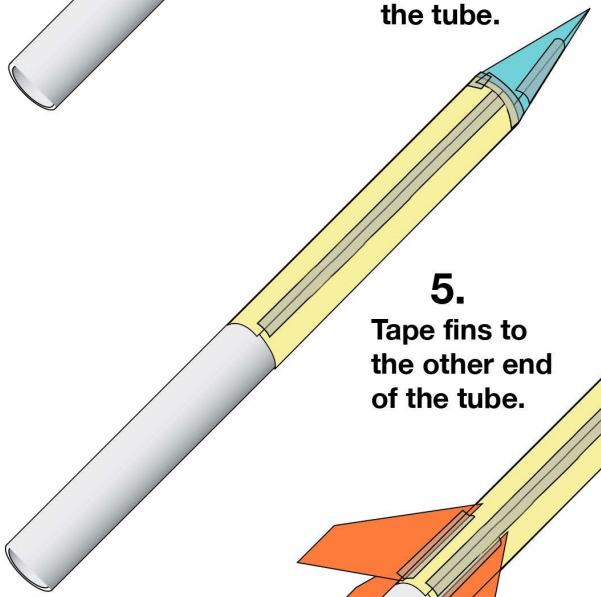


2.
Tape the seam of the tube.

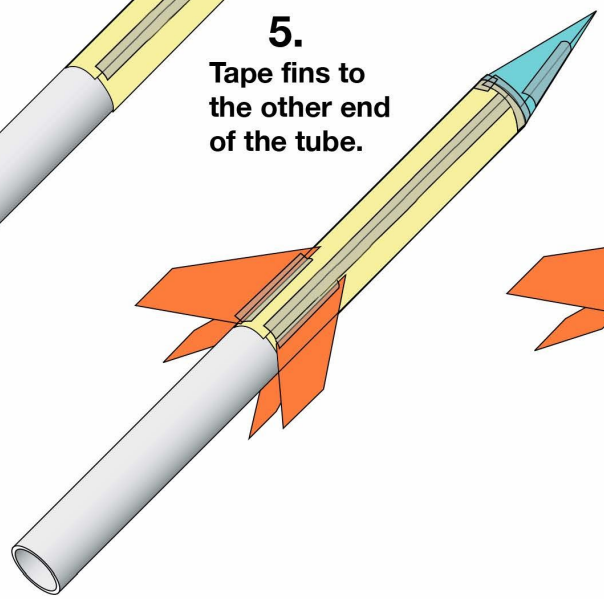


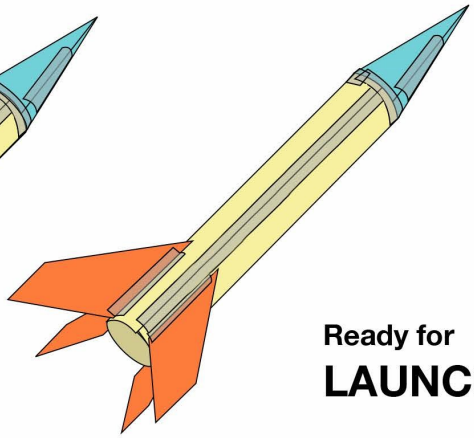
3.
Curl a nose cone from a semicircle. Tape the seam.

4.
Trim the cone to fit the tube. Tape it to the tube.



5.
Tape fins to the other end of the tube.





Ready for
LAUNCH!

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Procedure for Event Leaders / Volunteers

1. Prior to the launch, assemble enough PVC launchers to make sure every anticipated participant will have their own launcher. Instructions for assembly are shown below.
2. Make sure the duct tape seal between the bottle and launcher is as air-tight as possible. This will ensure the best possible launches.
3. In addition to having a premade stomp rocket as an example, demonstrate the process of making the rocket by building an example before participants begin working.
4. While participants are working, assist them in building their rockets as needed. Be sure to check that participants are not making their rocket too tight, as this will prevent their rocket from launching. Additionally, check the tape seals of the rockets to make sure they are as air-tight as possible which will also play an important role during launch.

Launching the Rockets:

1. Because of their lightweight design, stomp rockets perform best on non-windy days. If you are located in a windy location, try to orient your launch location behind a windbreak such as a gymnasium or other large building.
2. Secure an outdoor location that is clear of overhead obstructions (trees, building roofs, power lines, etc.) and has a ground area of at least 100 meters by 25 meters for best altitude-tracking results. A shorter, 50-meter or 25-meter baseline may also be used.
3. Be sure participants stomp in the middle of the bottle, perpendicular to the body of the bottle. This is the most flexible zone of the bottle and allows for it to be reused numerous times. If participants stomp on the bottom end of the bottle, it will often shatter, rendering the bottle unusable.
4. Bottles can be easily re-inflated using air from your lungs. Have the participants place their hand in a fist around the open end of the launch tube and blow to re-inflate the bottle. Using their fists protects participants from the unsanitary conditions that may exist on the rocket launcher.
5. Use caution when launching the stomp rockets. Keep all participants clear of the launch tube and the landing area. Allow only one participant (the "stomper") to be near the launcher, and be sure the launch tube is pointed away from the "stomper." Only retrieve rockets once they have all landed.

Building the Stomp Rocket Launchers

1. Take one PVC section labeled "20" and insert into one of the two remaining open slots of the 4-way tee connector.
2. Now take one PVC section labeled "12" and insert it into the last remaining open slot of the 4-way tee connector.
3. Use duct tape to secure the nozzle of the 2-liter bottle to the open end of the PVC section labeled "20." This connection must be air-tight, so use enough tape to ensure no air escapes.