activity seven

A High Velocity, High Altitude, High Pressure Air Powered Paper Model Rocket!

OBJECTIVE

The senior member will learn how to build paper model rockets that are capable of withstanding the extreme pressures of a high-powered compressed air launcher. The model rocket featured in this activity will be able to travel at speeds comparable to commercially-produced solid fuel model rockets.

BACKGROUND

Air Rocketry involves the flight of rockets using compressed air as the motive force. This method of building and launching model rockets is very inexpensive and fun. For not much more than the cost of a sheet of card stock paper and a few feet of reinforced tape, the builder can achieve unbelievable velocities and altitudes

CREDITS

High pressure, high velocity paper rockets are a specialty of Dr. Charley Rodriguez. He is truly a rocket scientist and is the Assistant Professor of the Aviation Technologies Department, College of Applied Sciences and Arts at the University of Southern Illinois. Dr. Rodreguez and numerous students have conducted *sophisticated experiments with this technology and* have achieved incredible distances and altitudes with various launch pressures.

Professor Rodriguez has always been a supporter of Civil Air Patrol's Aerospace Education Program and it is with his permission that excerpts from his ***Air-Powered Rockets*** paper, copyright 2000, are used in *this activity.*

NATIONAL SCIENCE STANDARDS

Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard B: Physical Science
- Motions and forces

Content Standard E: Science and Technology
- Abilities of technological design
- Understanding about science and technology

Unifying Concepts and Processes
- Evidence, models, and explanation

PAPER ROCKETS

The performance of these rockets must be regulated depending upon the actual usage. **If a senior member wants to challenge a group of cadets, it is advised that low pressures and simple, reinforced paper tubes be used at first**. For a more advanced group, such as members of a senior squadron, the builders are encourages to experiment with different pressures, fin configurations, nose cones, and other variables to achieve higher velocities and greater distances.

In his paper, Dr. Rodriguez addresses the issue of the launch area. "Another variable that may limit this form of model rocketry is the launch area. When launching high pressure rockets for maximum distance, ensure that the firing range has around 1,000 square feet of linear open space. That's more than three football fields end-to-end. In terms of width, the firing range should have at least 150 feet. Unless the rocket has some unsavory design flaw, it should safely touch down within the prescribed area. Low pressure rockets may be fired within an area the size of a football field."

CAUTION

As an adult member, **SAFETY SHOULD BE YOUR PRIME CONCERN, especially when working with cadets or students. Consider also the structural integrity of the launcher, the safety of *the firing range and the area around the launch* site. It is always a good policy to have those involved in the launch procedure wearing safety glasses. It is also imperative that low or high *pressure devices never be aimed in a direction* that may cause injury or damage.**

LOW PRESSURE ROCKETS

Low pressure rockets are easily constructed from standard 8fi x 11 sheets of paper. Experiments will prove that different lengths of paper affect the performance of a model rocket and this adds to the excitement and educational value.

Launch pressures should not exceed 80 psi.

Pressures in the range of 40-60 psi will provide adequate performance. If excessive pressure is used during a launch, it is likely that the rocket will be unable to withstand the force. Consequently, the rocket may develop a tear or even explode in shreds of confetti. For this reason, it is a good policy to keep everyone behind the launcher during operations.

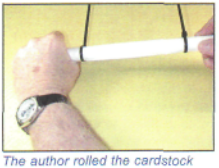
THE EXTREME PAPER ROCKET

CONSTRUCTION PROCEDURE FOR A HIGH PRESSURE, HIGH VELOCITY, HIGH ALTITUDE PAPER BALLISTIC MISSILE

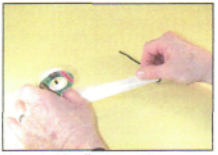
The tube, mounted to the launcher that was featured in Activity Six uses fi" x 12" PVC. The first step in the "Extreme Paper Rocket" construction is to wrap a sheet of paper card stock around the tube "not too tight and not too loose!" The tube becomes the "mold" for the body of the rocket. **If the rocket is too tight it will create too much internal pressure and may not leave the launcher. In some cases, it may even blow up.** "If too loose," says Dr. Rodriguez, valuable liftoff pressure will escape between the inside diameter of the rocket and the outside diameter of the launch tube."

The rocket selected for this activity is going to be strong enough for a maximum pressure launch. The construction sequence shows the use of washers for ballast and nylon-reinforced packing tape for strength. Remember, SAFETY must be the builder's first consideration. Any experimenting should be done with caution, be it low, medium or high pressure.

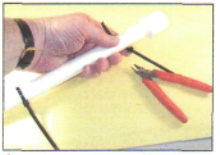
The materials you will need to build a high pressure paper rocket include #65 paper card stock, duct tape, household (Scotch®) tape, nylon-reinforced packaging tape, scissors, and washers. The ones used for ballast in this activity were 7/8" and fi" fender washers.



The author rolled the cardstock around the PVC launch tube and secured the paper with two cable ties. This kept the paper in place while tape was applied to the seam.

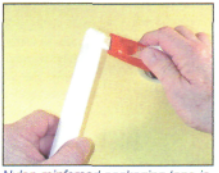


Household cellophane (like Scotch® brand) tape was applied to the seam to hold the tube in place.

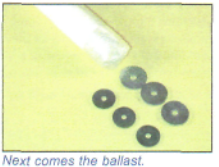


Once the tape is in position, the cable ties are cut away.

The "nose" portion is now crimped down and sealed at one end.



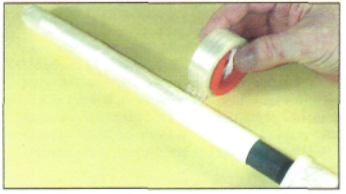
Nylon-reinforced packaging tape is used to seal the crimped end.



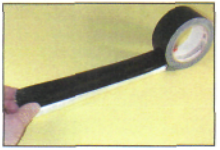
Next comes the ballast. Dr. Rodriguez recommended three washers for a first try. Two larger 7/8" and one fi" fender washers were used.

The author used super glue to hold the washers in place for this photograph.

The nylon packaging tape is used to seal the ballast washers in place.



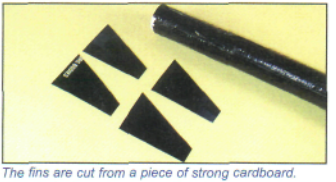
To keep the paper tube from collapsing, the author left it on the PVC tube while packaging tape was used to wrap the entire fuselage. Note that the packaging tape was wrapped 90 degrees to the length (longitudinal axis) of the rocket body while the duct tape (next picture) is applied parallel to this axis. This makes for better flight dynamics by reducing the drag of the rocket.



Duct tape was then used to seal the packaging tape.

A paper drinking cup makes an excellent nose cone. If the builder does not have access to one of these cups, a simple cone can be made by cutting out a card stock circle and making a cut somewhere in the radius. The paper can then be folded into a cone and sealed with tape.

The nose cone is sealed using the nylon-reinforced packaging tape. Make sure this process results in a smooth surface. Carefully shape the tape to make it form a good point.



The fins are cut from a piece of strong cardboard. The stock shown here was taken from a container that was about the same thickness as a cereal box.

The author elected to paint the nose and tail a glossy black to match the color of the duct tape used in fuselage construction.

To give it an "official" look, CAP seals were applied to the finished rocket. This little missile may be "dirt cheap," but it's capable of speeds in excess of 100 miles per hour and launch pressures in excess of 200 psi!

This is not a toy and should be launched with the same safety procedures and concerns as one would use when launching a commercial solid-fuel model rocket.