

Industrial Strength Paper Rockets

Description: Students construct paper rockets and launch them with an air pressure rocket launcher. Using simple sighting devices and basic trigonometry and algebra, the altitude the rockets' reach can be determined.

National Education Standards

Science

Unifying Concepts

- Change, constancy, and measurement

Physical Sciences

- Motions and Forces
- Transfer of energy

Science and Technology

- Abilities of technological design

Mathematics

Patterns, functions, and algebra

Geometry and Spatial Sense

Measurement

Data analysis, statistics, and probability

Technology Education

Design

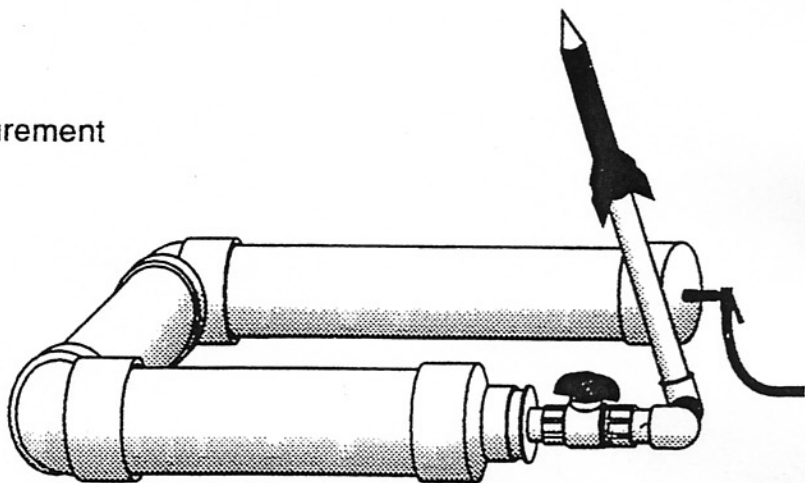
- Engineering design
- Troubleshooting, R&D, invention, innovation, and experimentation

Abilities for a Technological World

- Apply the design process

The Designed World

- Energy and power technologies
- Transportation technologies
- Manufacturing technologies
- Construction technologies



Materials Needed:

Paper

Cellophane Tape

Scissors

Rulers

Pencils

Rocket forms (short lengths of 1/2" PVC tubes)

Launcher (see diagrams for parts)

Electric air compressor or hand pump

Altitude trackers (refer to instruction pages)

Safety glasses for the launch

Time Needed:

Before Class - The launcher will require

1 - 2 hours to construct.

Class - Constructing the rockets will take about 1/2 hour

Launching and tracking the rockets will take about 1 hour

Calculating the altitude of the rockets will take about 1/2 hour

Constructing the Air Pressure Launcher

The air pressure launcher is made from Schedule 40 PVC plumbing parts available at most hardware stores. Refer to the diagrams for the specific parts needed. Clerks at the hardware store can help select the parts for you from the diagrams. Be sure to get pressure pipes for the 3", 3/4", and 1/2" tubing.

Using a saw, cut three pieces from the 3" pipe. The pieces should be 17, 6, and 5 inches long. PVC cuts very easily. Remove any burrs from the cut and clean the pipe if it is dirty.

Using a drill and bit, drill a hole into the center of the 3" end cap. The size of the hole will depend upon the diameter of the tire valve stem. The hole should be just smaller than the diameter of the rubber stem so that the stem seals itself to the cap when it is pushed through the hole from the inside out

Join the end cap to the 17-inch long 3" pipe segment with PVC cement. First clean both joining surfaces with PVC Purple Primer Cleaner. Make sure you are working in a well ventilated area away from open flame. When dry, coat the surfaces with PVC Cement and push the parts together immediately. Following the same cementing procedure, join one elbow to the other end of the pipe. Next, join the 5-inch long 3" pipe to the elbow. Join the remaining large elbow to the other end of this pipe segment. Be sure that both elbows are aimed in the same direction. The large tubes will serve as the launcher base and the pieces must not be twisted or the launcher will rock when it is being used. To insure proper alignment, set the base on the floor before the glue has set and press the second elbow until it is properly aligned.

Cement the 6-inch long 3" pipe to the elbow. Attach the 3" X 2" Coupling and the 2" X 3/4" Flush Bushing with cement to the other end of the tube.

Cut two 2" long pieces of 3/4" tube and prepare them for cementing. Join one to the flush bushing on one end and to the valve on the other end. Cement the second tube to the other end of the valve.

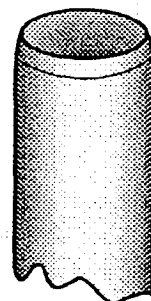
Cement the 3/4" elbow (with outside threads on one end) to the end of the second small tube. Screw the second elbow on to the first. Do not cement this elbow. It needs to be able to be rotated.

Cement the 3/4" X 1/2" Flush Bushing into the open end of the second elbow.

Cut an 18" long piece of 1/2" pipe and push it into the elbow. It can be cemented if you wish. This is the launch tube.

For extra strength, you can wrap the tubes with nylon filament tape. This is optional but recommended.

Tip: To make it easier to slip rockets on to the launch tube, use a file or sand paper to taper the upper end of the launch tube.



Rocket Construction:

Use the instruction sheet for constructing the paper rockets. Have your students roll paper around the short lengths of 1/2" PVC tube. The tubes serve as forms for constructing the rockets. For best performance, the paper should be snug on the form but able to slide easily. Make sure students firmly attach the fins and nose cone for their rockets. Poorly attached nose cones will blow off the rocket, leaving the rocket behind. Poorly made rocket bodies may explode into confetti while on the launch pad.

Launch Procedures:

Follow the instructions for constructing paper rockets. When the rockets are ready, follow these instructions for the launch.

1. Select a clear field for the launch. Although the rockets are made of paper, they can still cause injury if someone is struck by them.
2. Set up the launcher and orient the base so that the launch tube can point straight upward. If the wind is blowing, you will want to aim the angle of the tube slightly into the wind.
3. Connect the air compressor or hand pump to the tire valve on the launcher. With the valve closed, pump the launcher up to 30 pounds of pressure. Observe how far the rocket goes and in which direction. Make adjustments to the aiming and pump the launcher to 50 pounds of pressure. Again, test fire a rocket and make any final aiming adjustments.
4. Load the rocket on the launch rod. Clear the landing site from bystanders.
5. Perform a count down. If you will be determining how high the rocket flies, this lets trackers know when the rocket is about to launch.
6. Let only the builder of the rocket fetch it after it lands.

SAFETY RULES

Do not pump the launcher up to a pressure greater than half the rated pressure of the weakest part. The PVC pipes and the valve come with pressure ratings. If the lowest rating is 150 psi, do not pressurize the launcher to greater than 75 psi. This provides a significant safety margin.

Be careful in handling the launcher. PVC can crack if dropped or struck with sufficient force. Inspect the launcher before use. Discard a launcher that shows signs of cracking.

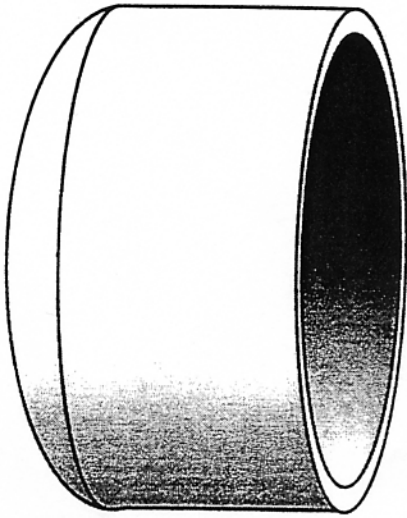
Do not lean over the launch rod at any time.

Do not place anything inside the launch rod.

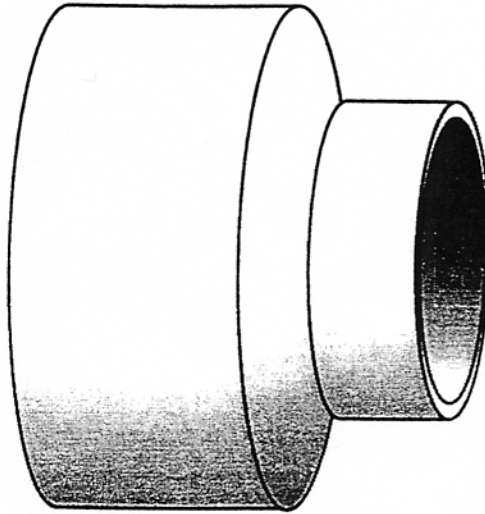
Wear eye protection for launches.

Tip: Some teachers have reported better flight performance with low-pressure launches than with high-pressure launches. Aerodynamic drag on the rocket increases with velocity. At higher initial velocities, rocket fins may be distorted, leading to even greater drag and diminished performance. How could students test this theory?

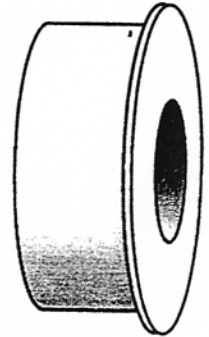
Air Pressure Rocket launcher Parts



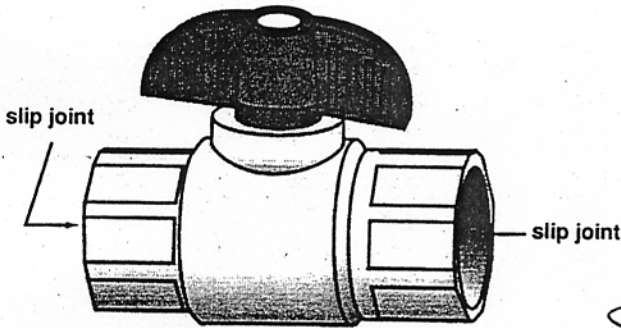
Schedule 40 3" Cap



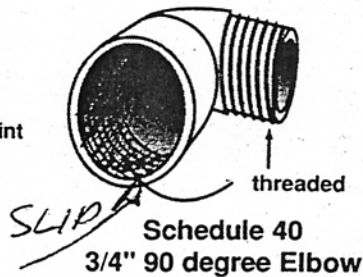
Schedule 40 3" X 2" Coupling



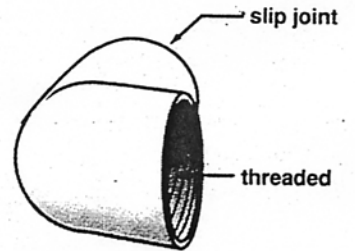
Schedule 40 Flush Bushing
2" X 3/4"



Schedule 40 Compact 3/4" Ball Valve



Schedule 40
3/4" 90 degree Elbow



Schedule 40
3/4" 90 degree Elbow .



Schedule 40 Flush Bushing
3/4" X 1/2"



Snap-in Tubeless Tire Valve
TR418 or similar

Other Materials:

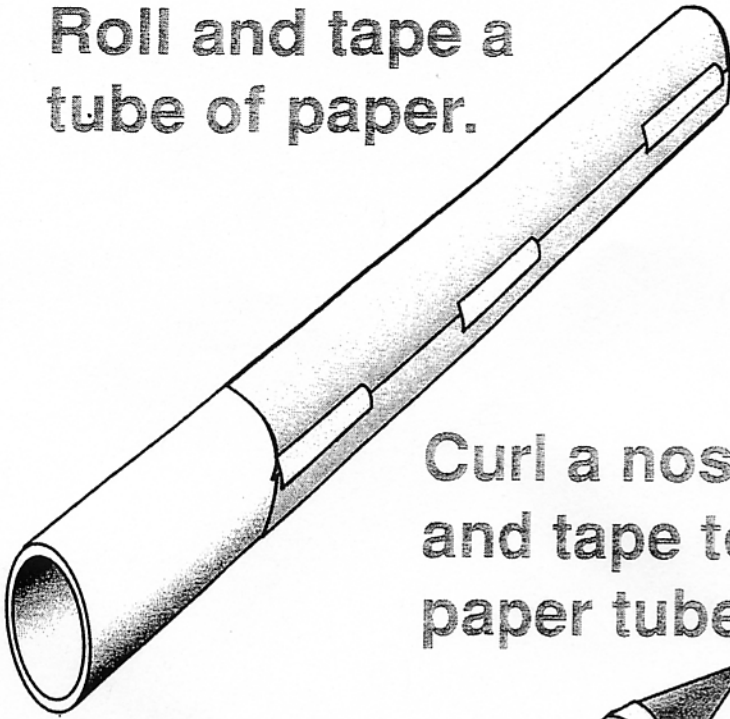
- Pipe: 3" pressure
- 3/4" pressure
- 1/2" pressure
- PVC Purple Primer
- PVC Cement

Tools: Saw for 3" pipe

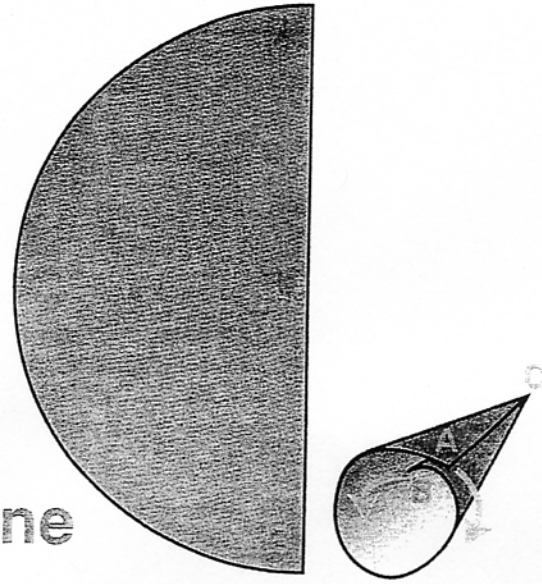
- (optional) PVC cutter for 3/4" and 1/2" pipe
- Drill and bit for tire valve hole

Making the Rocket

Roll and tape a tube of paper.

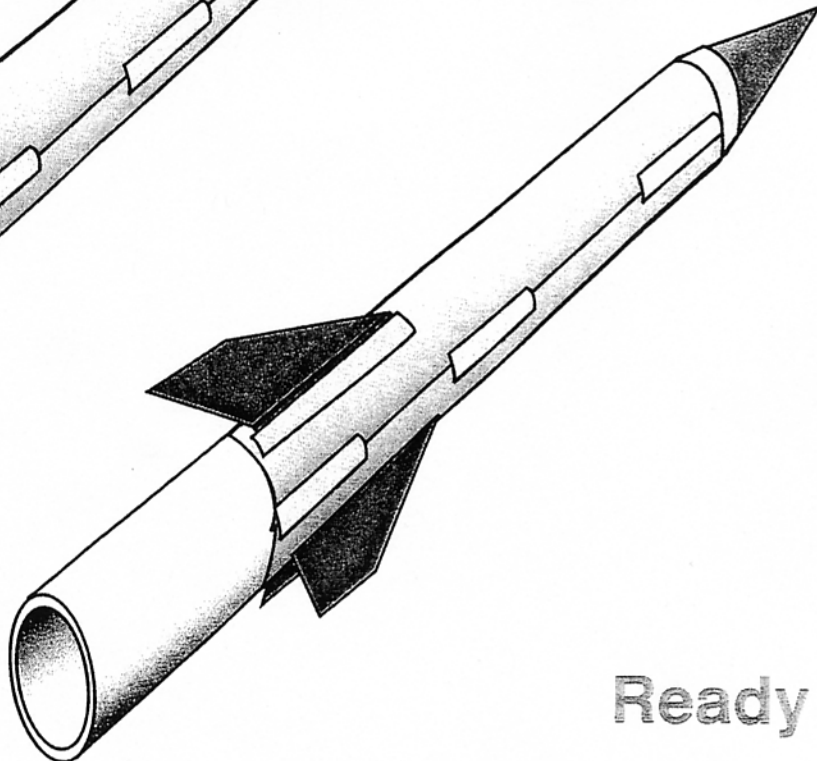
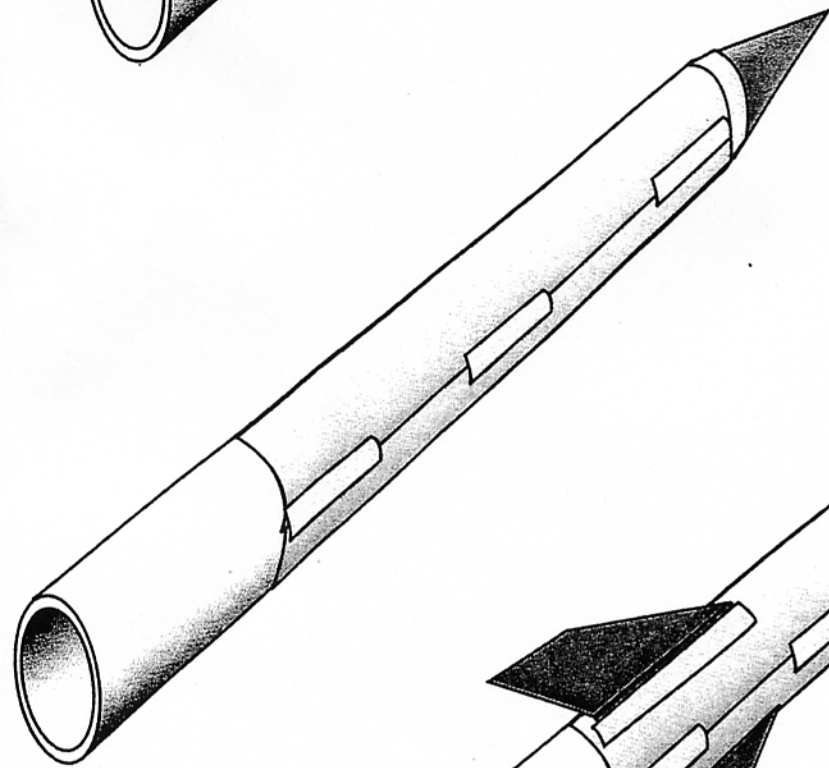


Curl a nose cone and tape to the paper tube.



Nose cone pattern
Curl B under A so
that C becomes
the point.

Attach 3 or 4 fins
to the paper tube.



Ready for flight!