BICYCLE PUMP AIR PRESSURE ROCKETS

Credit: Jeff Elmer, Physics Teacher, Oshkosh North High School

Concepts Illustrated:

(1) Forced air flight and Newton's 3rd Law
(2) Stability and aerodynamics of rocket structure
(3) Projectile motion, trajectory, and time of flight

Time Requirements: 15-45 minutes (Depending on how much you have kids construct and what type of qualitative or quantitative analysis is done, if any during walk-up activity)

Grade Level of Audience: This activity is suited for kids in grades K-12, depending on the complexity of the analysis.

RATIONAL FOR THIS DESIGN:

1. This air pressure rocket kit would require less maintenance than the traditional "stomp rocket" model.
    - No collection of plastic bottles required
    - No changing of bottles required as plastic bottles get worn out
2. More consistent pressure delivery to paper rocket, as the pressure will be determined by the number of pumps from a tire pump.
3. The launch mechanism allows for variable launch angle direction, which introduces trajectory into the rocketry experience.

I. Materials and Equipment Utilized

(Materials needed for a group of 20 students)

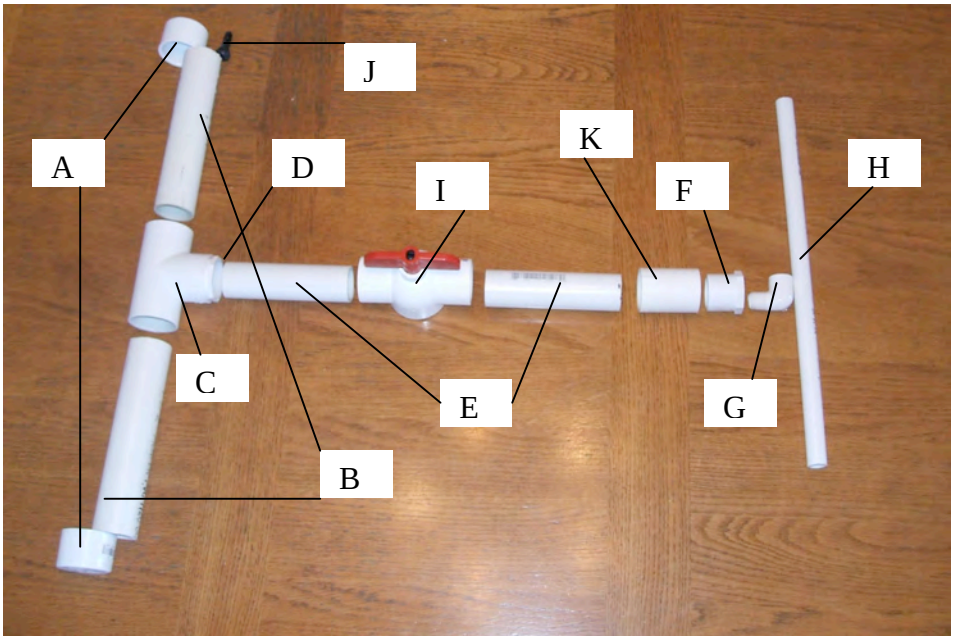
1. 2-4 Bicycle Pump Air Rocket launching apparatus (parts and construction details follow)
2. 11" x 14" pieces of paper for rocket bodies (construction details are listed below)
3. template for rocket fins (one copy needed for each student)
4. small piece of carboard (one piece for each student, must be large enough to provide rocket fins)
5. 10 Scissors
6. 5 rolls of Scotch tape
7. bag of cotton balls or box of plastic cellophane wrap (for nose cone)
8. markers for decorating

II. Description of Set-up and/or Construction of Apparatus

1. Making the Launcher

MATERIALS LIST FOR EACH LAUNCHER

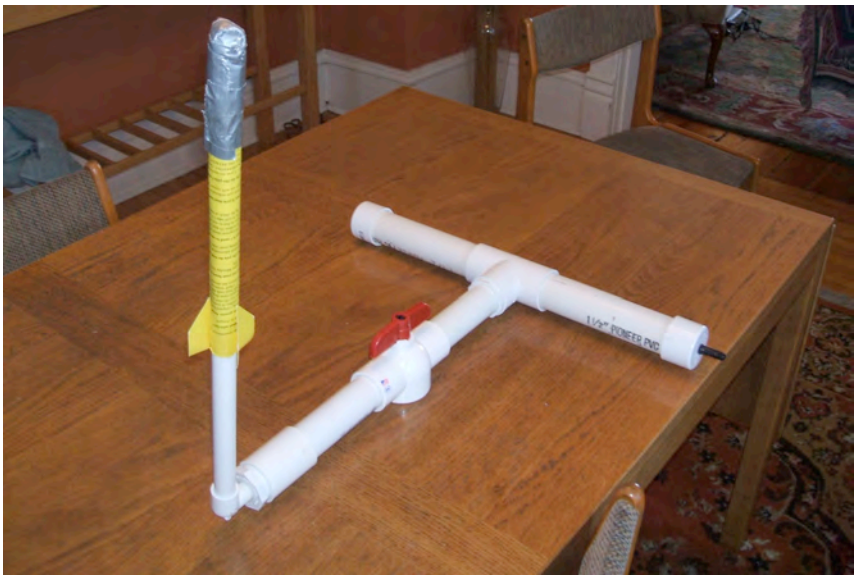
PART ID	QUANTITY	DESCRIPTION OF PART	COST OF PART
A	2	1.5” PVC schedule 40 end caps	$1.28
B	2	9” piece of 1.5” PVC schedule 40 pipe	$0.75
C	1	1.5” PVC schedule 40 tee	$1.32
D	1	1.5” x 1.25” PVC schedule 40 bushing	$0.68
E	2	6” piece of 1.25” PVC schedule 40 pipe	$0.50
F	1	1.25” x 0.50” PVC schedule 40 bushing	$1.07
G	1	0.50” PVC schedule 40, 90^{o} w/male threads	$0.46
H	1	18” piece of 0.50” PVC schedule 40 pipe	$0.30
I	1	1.25” PVC ball valve	$5.88
J	1	0.453” x 1.25” snap in tire valve	$2.25
K	1	1.25” PVC schedule 40 coupling	$0.40
		TOTAL	**$15.57**



CONSTRUCTION OF AIR PRESSURE ROCKET LAUNCHER

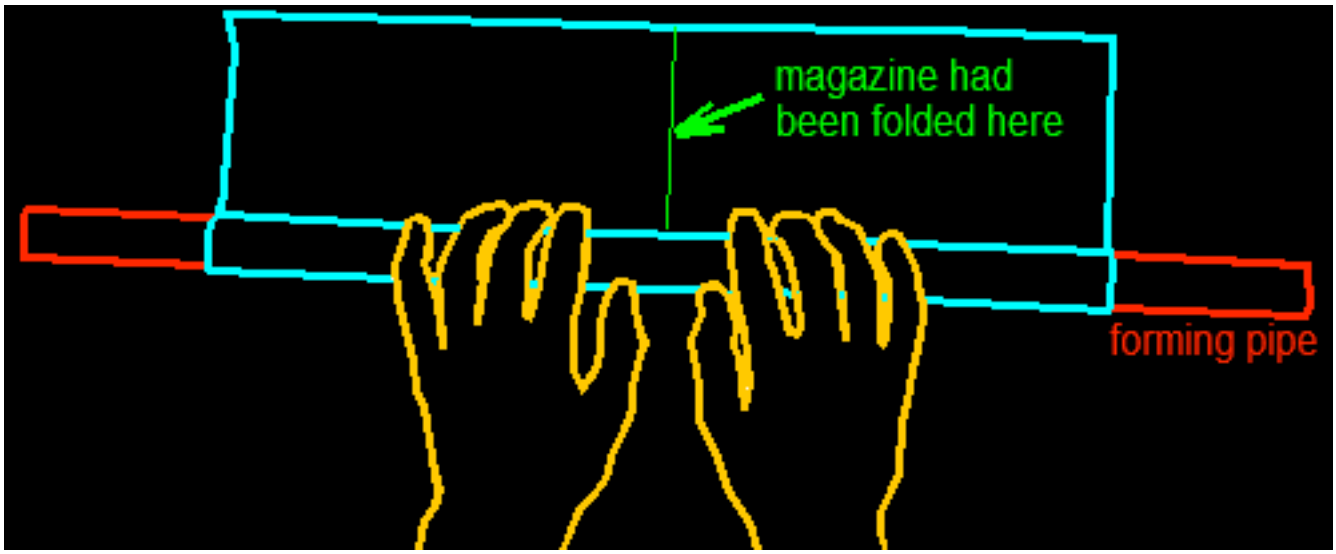
- Drill a 0.50“ hole in the center of one of the 1.5” end caps. Pull the snap in valve through the hole using a large pliers or channel locks.
- Use PVC cement to glue the 1.5” end caps to one end of each of the 9” pieces of 1.5” PVC.
- Glue the open end of each 9” piece of 1.5” PVC to the opposite sides of a 1.5” PVC tee.
- Glue the 1.5” by 1.25 “ bushing into the bottom of the 1.5” tee.

- Glue one end of the 6” piece of 1.25” PVC into the bushing just placed in side the tee and glue the other end into one side of the 1.25” PVC ball valve.
- *The rest of the set-up (low pressure side) is simply friction fitted together. This allow for easy disassembly and storage.*
- Insert one end of the second 6” piece of 1.25 “ PVC into the other side of the 1.25” PVC ball valve.
- Place the 1.25” coupling on the open end of the second 6” piece of 1.25 “ PVC. Insert the 1.25” by 0.50” bushing into the other side of the coupling.
- Screw the 90^{o}, 0.50” male threaded elbow into the 1.25” by 0.50 “ bushing. Turn the 90^{o} elbow until desired launch orientation is achieved.
- Place the 18” piece of 0.50” PVC into the elbow. The apparatus is now ready to launch paper rockets ☺.

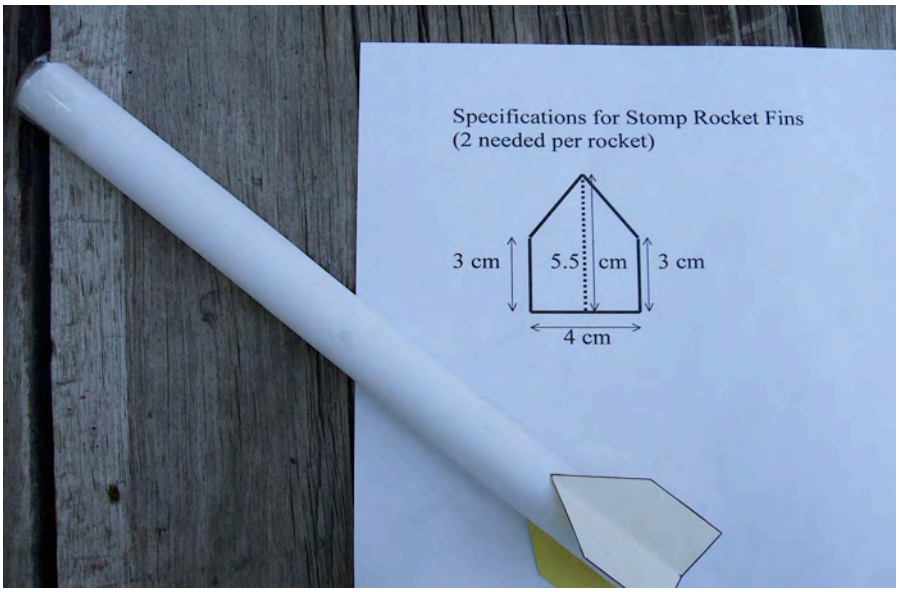


2. Making Rockets

- Roll the 11” x 17” piece of paper on the forming tube, such that, the longest possible tube is formed. The piece of paper should be wrapped tightly. If it is mushy, re-wrap it.



- Tape all along the seam to keep it from unwrapping. The rocket body is now complete.
- After much use, if the seam shifts or becomes tattered, simply slide the rocket body onto the forming tube, such that only about ½” of the tattered end hangs over the edge. Apply a small strip of tape to both sides of the seam.
- Cut out the fins provided and fold on the dashed line, bending the tabs in alternate directions.



- Tape the fins to the bottom of the rocket tube.
- The top of the rocket must be closed so the blast of air from the launcher will be trapped, pushing the rocket up. With one's thumb, push over ½" of the rocket tube. Then push on the other side and push over the paper there. Now there are two peaks left. Fold those over one at a time too (shown below). Now when the top is taped, the paper at the end will give it sufficient strength.
- One should make a rounded, soft nose cone for safety and efficiency. The softness of the nose will absorb some of the shock as the rocket hits the ground so the rocket tube doesn't get too banged up. **This may be done using a cotton ball or a small, wadded up, piece of clear plastic food wrap.** With a piece of tape, tape the cotton ball or ball of plastic to the top of the rocket, as shown below. The tape will form an upside down "U" with the middle curving around the top of the plastic ball and then ends taped to the rocket tube.
- Depending on time constraints, one may decorate one's rocket.

III. Details of Student Implementation

1. Care needs to be provided so that the rockets are not launched at peopleThe launcher MUST be initially tested outside. With some modifications, one may test in tall ceiling buildings, such as hangars, auditoriums, and gymnasiums.
2. After placing the rocket on the launcher, with the value closed, attach a tire pump and give two or three pumps. With the area secure, open the value and watch the rocket fly!

3. Time permitting and based on ability, analyses of height and time could be done.