Stomp Rockets

The foot goes down and the rocket goes up.

Parts:

2	Models
1	Inner tube, 10” more or less
1	PVC tube, 2’ more or less
	Duct tape
	Paper, 8 ½ x 11 or larger
	Bottle
	White tape
	File folders or stiff paper
	Yarn (for target)

Extra Tools:

PVC cutter
¼” dowel, 12” for pushing through nose cone - several

Concepts:

1. The air gets forced out of the bottle when you reduce the bottles volume by smashing it.
2. The air pushes the bottle up. When the bottle leaves the tube, it doesn’t get pushed any more.
3. The rocket is going as fast as it will go just as it comes off the tube. Then it goes slower and slower until it stops, and then starts accelerating toward the ground.

Questions:

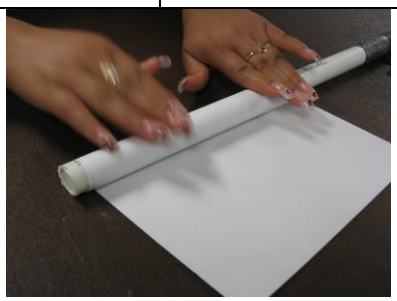
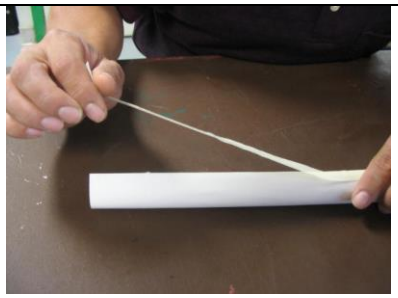
A. Why might a big bottle work better than a small bottle?
B. What do you think would happen if you made the tube a lot longer?
C. Why do you think the rocket goes up when you stomp on the bottle?
D. Where do you think the rocket is going the fastest?

How we build it:

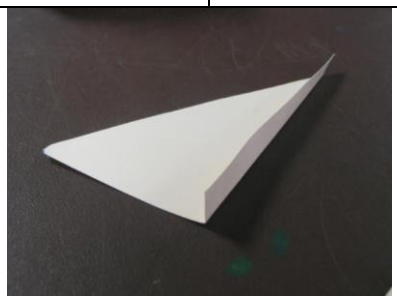
Force the mouth of the bottle into the inner tube. Tape it tightly with duct tape.

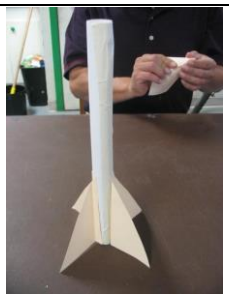

Cut a piece of PVC and insert it into the other end of the inner tube. Duct tape this joint tightly also. This is the launcher.


Roll a piece of paper around the PVC. Make it tight, but so that it slides easily up and down the PVC. The paper shown here is being rolled lengthwise, but rolling the other direction to make a longer rocket also works. Add masking tape along the length of the tube to hold the paper closed.

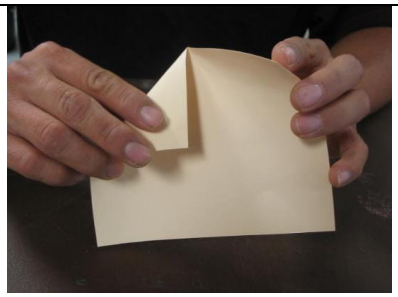



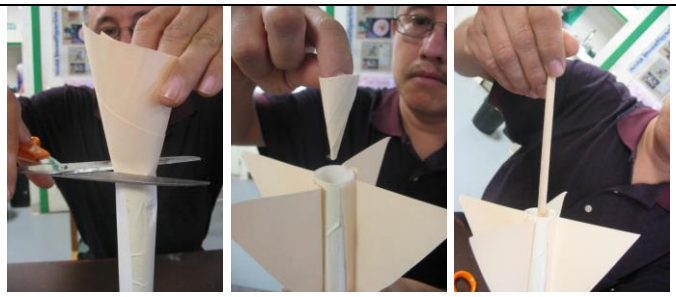
Make at least three fins and glue them on the lower end of the rocket.





Make a cone from a piece of stiff paper. Tape it tightly.



Insert it into the rocket and cut it off flush. Use the dowel to push the cone through the tube until it sticks out the opposite end.	
Pull it out until it is just about to pop out of the tube. Position it correctly and hot glue it into position. There should be no holes for air to escape.	
Take the rocket outside to launch. Slide the rocket onto the PVC. Hold the PVC below the rocket and stomp on the bottle. Be careful not to shoot yourself in the face. Two people can launch very well: one to stomp and one to aim.	

A bit more info:

The force that pushes this rocket up comes from the air escaping from the bottle. When you stomp the bottle, its volume decreases. This increases the pressure of the air inside the bottle, and it looks for a place to escape. It takes the only route of escape: out the neck and through the tubes. Then it encounters the rocket. It has to push on the rocket to get out of the tube.

The rocket is pushed for the length of time it is on the PVC tube, and then a few more inches after it comes off. After that there is no more push. So really it is less like a rocket and more like a bullet or a ball being thrown. Projectiles that don't have their own energy source accelerate only while they are in contact with their launcher. This is an example of Newton's second law: an object will accelerate according to how much force is put on it, and when the force is no longer there, it will no longer accelerate. The stomp rocket is going as fast as it ever will go just as it comes off the end of the tube. Real rockets will continue to accelerate as long as there is hot gas escaping from their rocket nozzles.

You can divide the motion of the rocket into vertical and horizontal elements. In physics, these are called vectors. If you think about only the vertical element – a flight straight up and straight down – it is easier to understand the motion. As soon as the rocket leaves the tube it has no more force up, but gravity is always pulling it down. The rocket begins to slow down and continues slowing until it stops at the top of its path. Then, it turns around and begins accelerating again toward the ground, this time powered entirely by gravity. It turns out that the speed of the rocket when it hits the ground is exactly what it was when it left the ground on its way up.

It is harder to consider the sideways vector alone because we have no experience living without gravity. If one were to launch this rocket in space where there is no gravity or air, it would accelerate for the length of the

PVC, attain its maximum speed, and then continue on with that speed until it hit something. This is an example of Newton's first law: objects in motion tend to stay in motion and objects at rest tend to stay at rest. Here on earth, the air that the rocket encounters slows its sideways motion.

The result of these two different vectors of motion is a curved path called a parabola. Everything thrown up from the earth follows a parabola (if you ignore influence from the air). You can see it in ball games, bomb blasts and when you throw a rock.

A bigger bottle would have more air and thus be able to give more force to the rocket. The longer the tube is, the more air is inside it, and the more air must be pushed. Air is springy (unlike water) and so is the bicycle inner tube, so the longer the tube is, the less directly the air will be pushing on the rocket. With a very long tube, there would be a delay between the stomp of the bottle and the launch of the rocket.