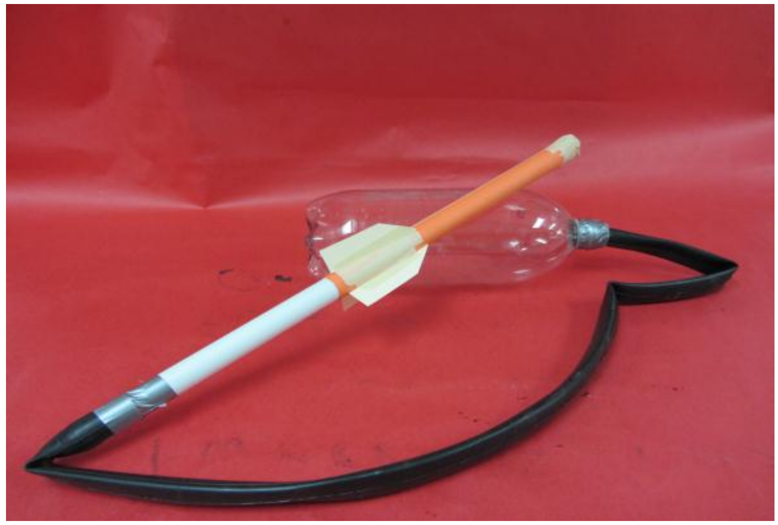
Stomp Rocket



Category: Physics: Force and Motion

Type: Make & Take

Rough Parts List:

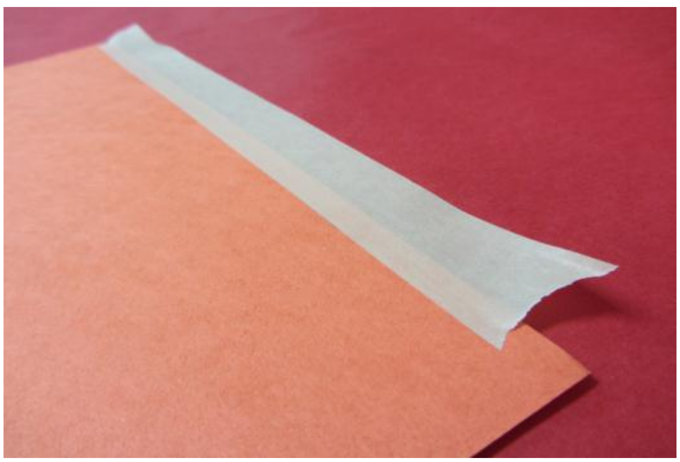
1	Construction paper
1	Folder
1	Bike tube
1	2-liter or other size bottle
1	PVC pipe

Tools List:

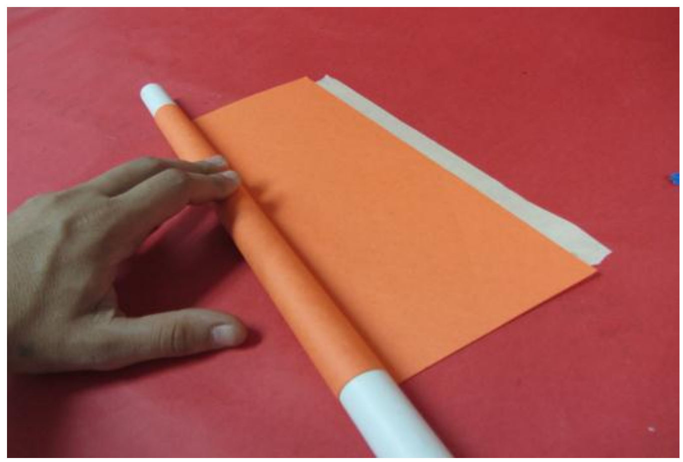
Masking Tape
Duct Tape
Scissors

Video: **http://www.youtube.com/user/FresnoCSW/videos**

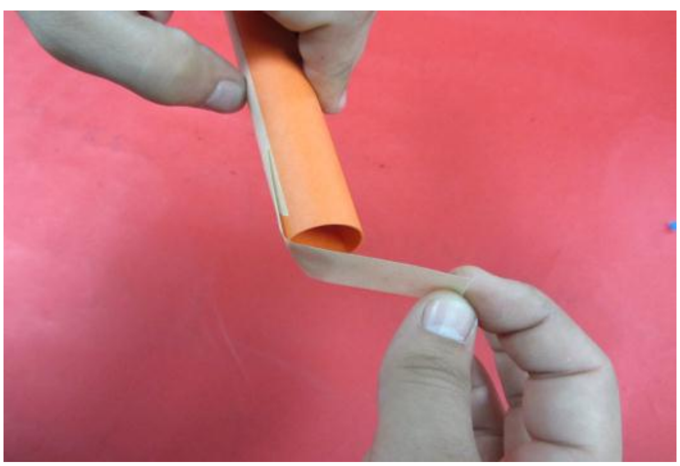
How To:



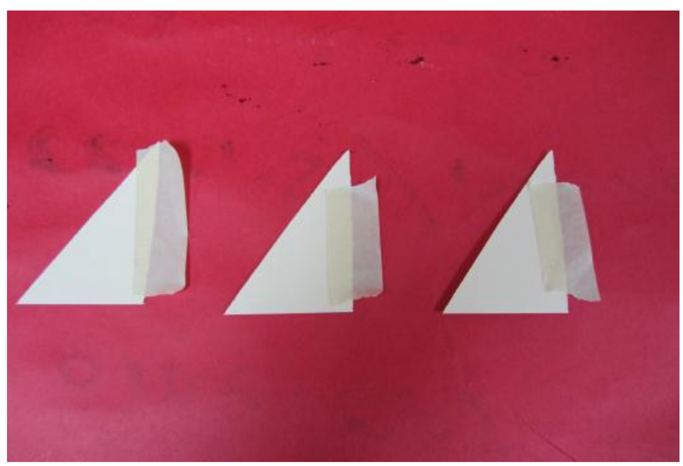
Place tape along one edge of construction paper.



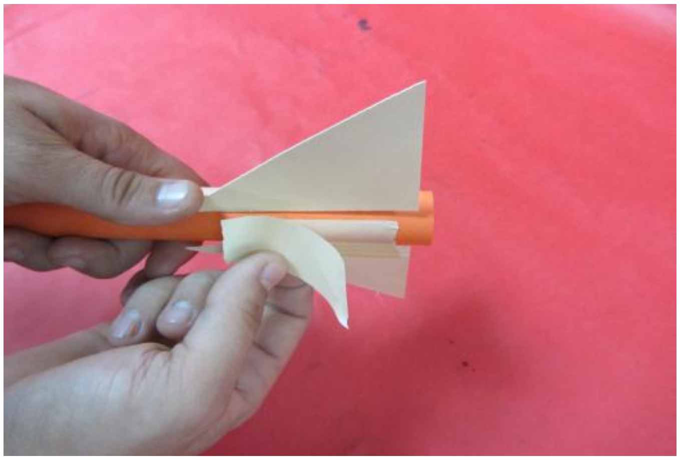
Flip the paper over and
roll the PVC pipe towards the tape.



Remove the pvc pipe and tape the rolled paper.
Tape over one end of the paper tube.



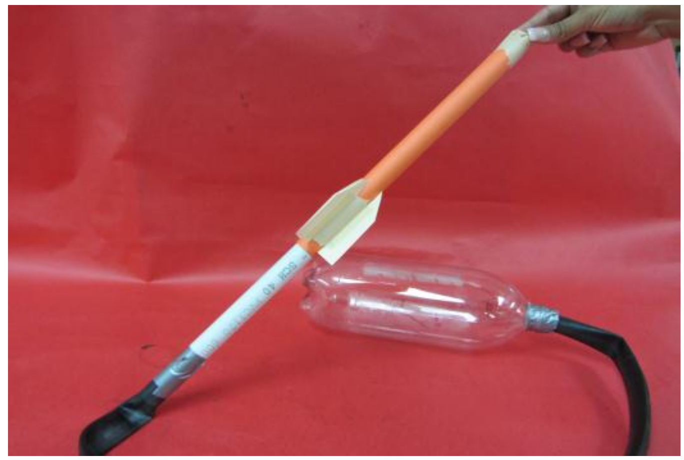
Cut three fins from a folder.
Place tape on each fin.



Tape the fins to the rocket. Add tape to the other side of the fins for reinforcement.

Cut the bike tube. Slide one end onto the end of a PVC pipe and tape in place.

Wrap the other end of bike tube around the lip of a 2-liter bottle and tape in place.



Slide the rocket onto the free end of PVC pipe, stomp on the 2-liter bottle and watch the rocket launch!

Fine Points:

→ Be sure the ends of the tire tube are completely sealed and no air can escape.
→ Experiment with fin size to make the rocket shoot further or higher.
→ Experiment with different sized paper and different nose shapes.

Concepts Involved:

- Air is forced out of the bottle when the bottle's volume is reduced by smashing it.
- Air pushes the rocket up. When the rocket leaves the tube, it does not get pushed any more.
- The rocket is moving at its fastest just as it comes off the tube. It continues to slow, eventually stopping, and then begins to accelerate back toward the ground.

Focus Questions:

1. How could the rocket be changed to fly further?
2. Would adding weight to the rocket change its flight?
3. Why might a big bottle work better than a small bottle?
4. What would happen if the tube were a lot longer?
5. At what point do you think the rocket is moving the fastest?
6. Why do you think the rocket goes up when you stomp on the bottle?

Elaboration:

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 will ever 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 pushing it up, but gravity is always pulling it down. The rocket begins to slow 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. If there were no air resistance on the rocket, the speed of the rocket when it hits the ground would be 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 hitting 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 throwing a rock.

A bigger bottle would have more air and thus be able to give more force to the rocket. The longer the tube, 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.

Links to k-12 CA Content Standards:

Grades k-8 Standard Set Investigation and Experimentation:
Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations.

Grades k-12 Mathematical Reasoning:

1.0 Students make decisions about how to approach problems:
1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.
1.2 Determine when and how to break a problem into simpler parts.

2.0 Students use strategies, skills, and concepts in finding solutions:
1.1 Use estimation to verify the reasonableness of calculated results.
1.2 2.2 Apply strategies and results from simpler problems to more complex problems.
1.3 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
2.5 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

3.0 Students move beyond a particular problem by generalizing to other situations:
3.1 Evaluate the reasonableness of the solution in the context of the original situation.
3.2 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.
3.3 Develop generalizations of the results obtained and apply them in other circumstances.