Week 10 & 11 – Rockets to the Moon!

Summary:

To do the bottle rocket experiment, each classroom will need a rocket launcher. Each group (desk clump) will build their own bottle rocket in the first week of the experiment and launch them in the second week.

One of the most basic laws in physics are Newton's three laws:

1. An object in motion stays in motion, an object at rest stays are rest; unless they are acted on by another force
2. F=ma
3. For every action there is an equal and opposite reaction

This experiment is done to reintroduce the basic idea of Newton's 3rd law we looked at during the balloon rockets. From a conceptual standpoint, Newton's third law is seen when a person walks: they push against the floor, and the floor pushes against the person. Similarly, the tires of a car push against the road while the road pushes back on the tires—the tires and road push against each other. This action reaction force can be used to build a rocket.

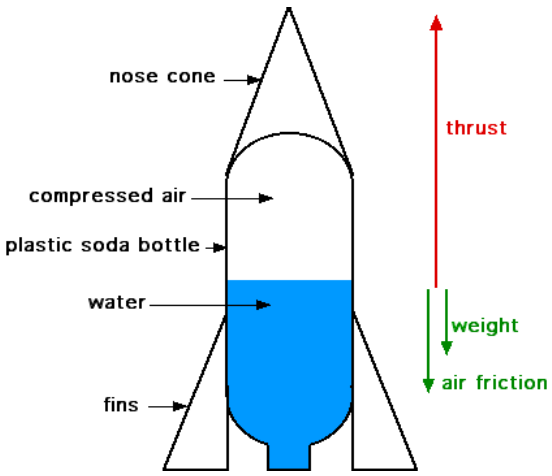
Related Links:

Experiment (http://www.timhesterberg.net/water-bottle-rockets/how-to)
Why Fins (http://wiki.answers.com/Q/Why_do_rockets_have_fin)

Materials:	Amount per Trial:
2 Liter Bottle	1
Manila Folder	2
Scissors	1
Playdough	3 Oz
Duct Tape	2 Rolls TOTAL
Markers	(Assorted)
Bike Pump and Bottle Launcher	1 (TOTAL)
Water	2/3 L

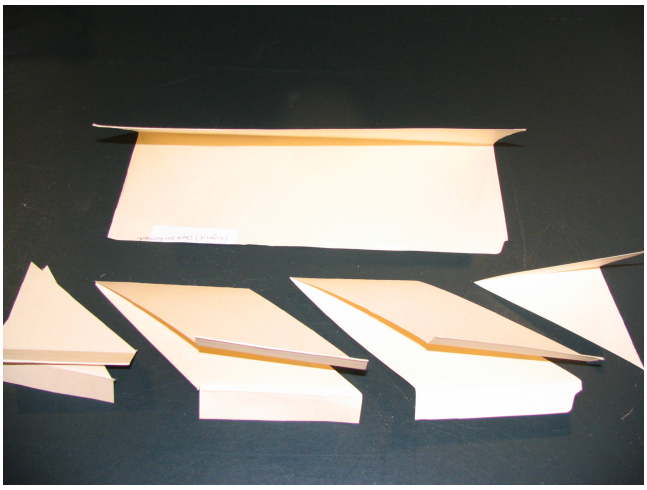
White Board Pictures:

- Draw the free body diagram of the bottle rocket with the forces acting on it
  1. Force on the bottle resulting from the air escaping out in the direction of travel (thrust)
  2. Air friction
  3. Force of Gravity as opposing force

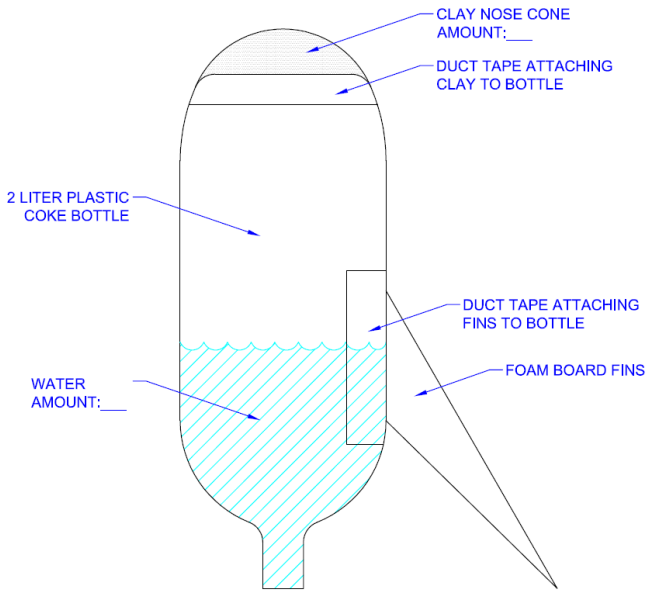


Week 10 - How to build the bottle rocket:

1. Mold the playdough into the ridges on the bottom of the bottle to form a rounded end. Then cover with duct tape. This is to stabilize the center of gravity of the bottle rocket.
2. To make the fins, cut a manila folder in half along the fold. Fold each half in half again the long way. Each half will make two wings. Cut each folded half diagonally to make two wings. See image below for reference. The angle is up to the kids, but make sure they cut it somewhere between 30 and 60 degrees. Otherwise it may not be very effective since the surface area will decrease.



3. To make the fins, take the unhinged ends of each fin and fold it over about a centimeter. See above image.
4. Ask the kids to decorate their wings and bottle with stickers or markers.
5. Tape the 4 fins by these 1cm folded flaps equally around the bottle rocket as shown below. Tape the fins as close to the bottleneck but just before the bottle starts to curve.



SIDE VIEW

6. Optional: Make a nose cone for the bottle around the play dough to make it aerodynamic.
7. Keep the rockets in the classroom until the following week.

WEEK 11 - How to launch the bottle rocket:

Be sure to launch the bottle in an open area outdoors!! Make sure there are no kids running around the area since the rockets come down at high velocities and can injure someone. Only scouts are allowed to launch the rockets.

1. Flip the rocket upside down and fill it a third full of water
2. Hold the bottle at an angle and insert the PVC rocket stand into the rocket without losing any water
3. Make sure all the zip ties are clasped around the bottleneck and then slide the plastic ring up so it is stuck via friction
4. Flip over the contraption and set it on the ground
5. Attach a bike pump to the launcher
6. Use the bike pump to increase the pressure to about from 40-60 psi.
7. Release the clasp mechanism and launch!

How does this work?

- Force- is any influence that causes an object to undergo a certain change concerning its movement or direction
- Friction- Air resistance is the friction in this experiment. Air resistance is what causes objects in flight to slow down. (Ex. throwing a ball stops because air resistance is acting as an opposing force)

- In this experiment, we launch a bottle rocket to space (not really) using a bike pump and a launcher. What forces the bottle up into the air? According to Newton's Third Law of Motion, for every action there is an equal and opposite reaction. When the bike pump is used to pump air into the bottle, pressure builds up inside of it. The only thing keeping the bottle from moving is the clasp on the launcher. When you let go of the clasp, all of the pressurized air is forced downward. Because of the Third Law, that means that the bottle has to go upward in response to the air rushing downward.
- The playdough on the bottle helps move the center of mass of the bottle towards the top of the rocket. If the playdough wasn't there, the bottle would spin uncontrollably because the center of mass is exactly at the middle of the bottle. The fins on the bottle also help stabilize the bottle rocket in its flight, and that's the reason why real rockets have fins too.
    - FUN FACT: The purpose of putting fins on a rocket is to provide stability during flight, that is, to allow the rocket to maintain its orientation and intended flight path. If a rocket was launched without fins, it would soon begin to tumble after leaving the launcher, due to the way that aerodynamic and other forces (such as wind) act upon the rocket, in relation to the forces that are exerted upon the rocket (gravity).

Newton's Third Law of Motion: for every action, there is an equal and opposite reaction. The action here is the air being forced out of the rocket, and the reaction is the bottle flying upwards. This is also how rockets work: the rocket can fly out into space because it forces gas/fuel out the bottom end of it and thus moves upwards. In real rockets and space shuttles, the exhaust and flames we see is the same as the air and water that comes out of our rocket. If you have time, you will be able to launch the bottles multiple times, and you will see that the larger the pressure you input, the higher it goes. This makes sense because the more air

means a larger force air will exert on the bottle over a larger period of time, and thus will accelerate faster and achieve a higher distance.

Friction plays an important role in rockets. Air resistance opposes the rockets motion and wants it to slow down, but since the force from the air in the rocket is larger, it over comes friction. Frictional forces can be decreased by making the rocket more aerodynamic (like adding a cone). You will notice that real rockets have a sharp tip that is to over come friction because a sharper object can move air around it than a blunt object.