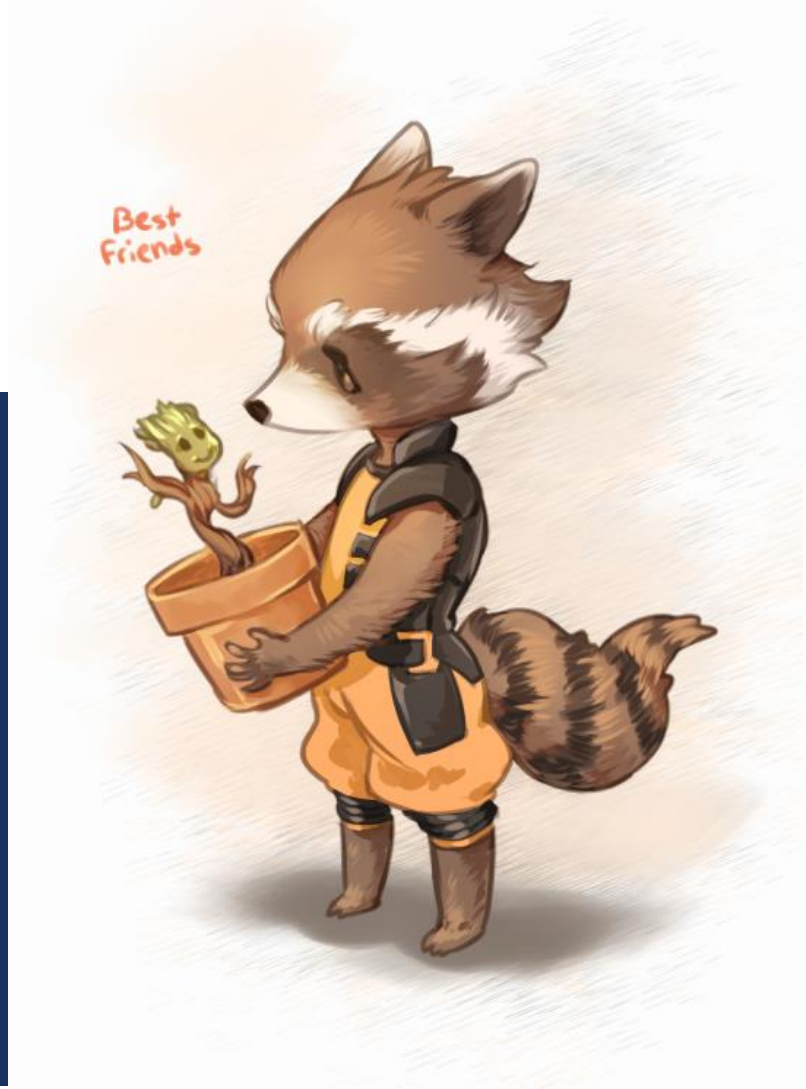
BOTTLE ROCKET PROJECT

CASTEEL HS 2017

G.BAKER THESCIENCEQUEEN.NET



WHAT IS A BOTTLE ROCKET?

- Water rockets have been a source of entertainment and education for many years. They are usually made with an empty two-liter plastic soda bottle by adding water and pressurizing it with air for launching.

Water Rockets - The Parts

Water rockets consist of the following parts:

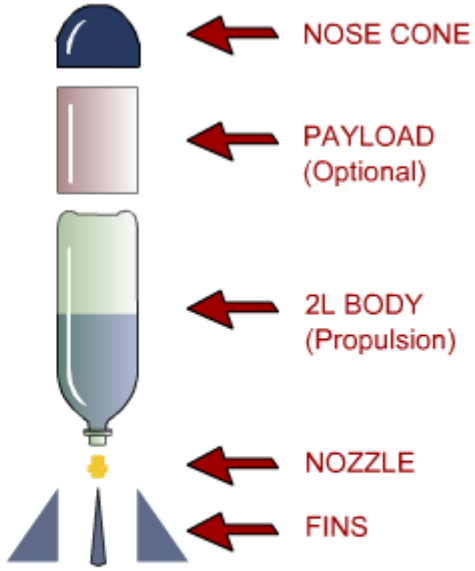
Nose Cone - an extension of the bottle that comes in a variety of shapes and is used to improve the aerodynamics of the rocket.

Payload section - an optional section that could hold a parachute or a payload.

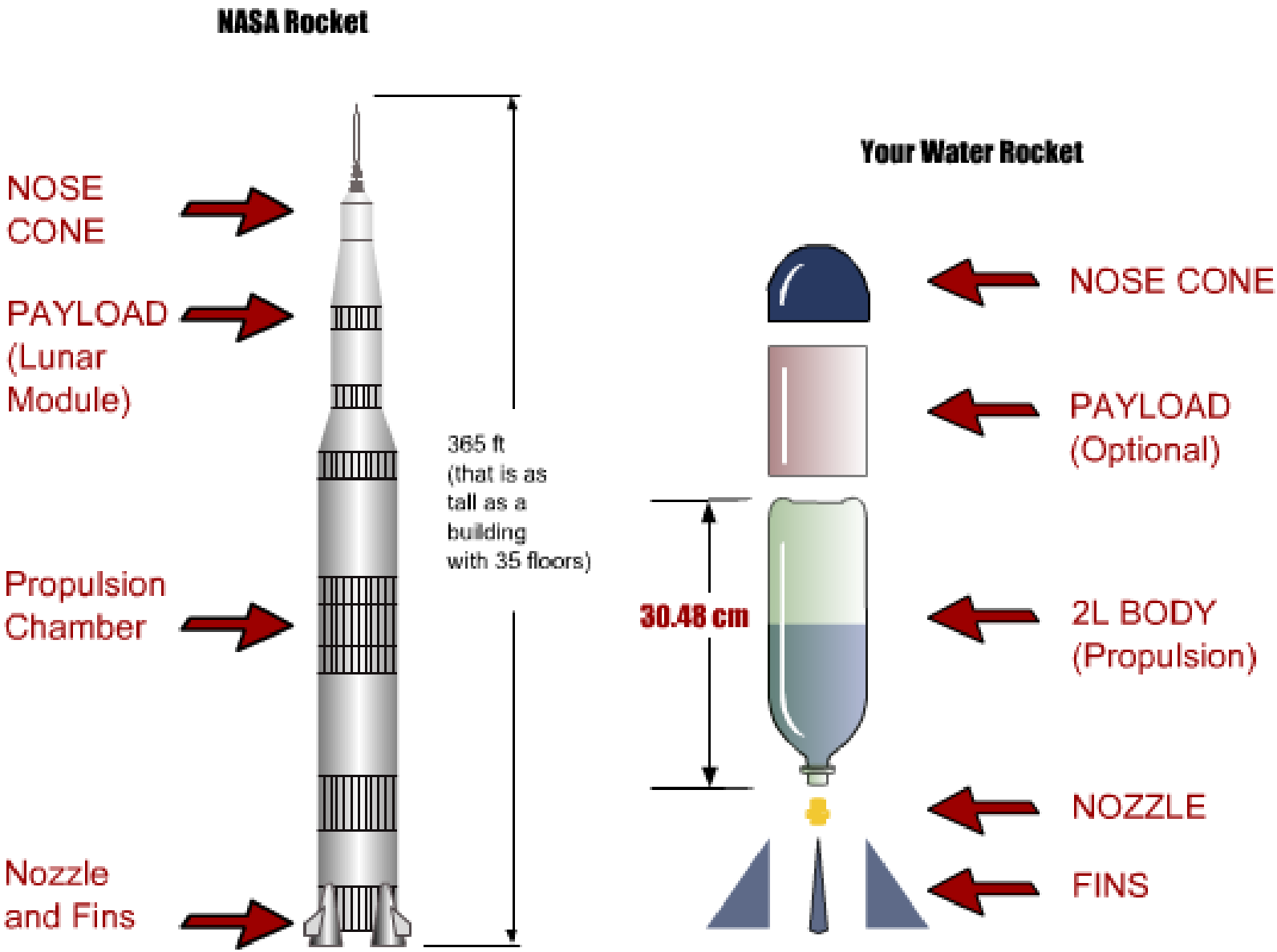
Body - a 2 liter soda or pop bottle that serves as the propusion compartment or "engine" of the water rocket.

Nozzle - a part that fits into the bottle opening to help in the propulsion of the rocket and provides a mounting point for launchers.

Fins - a part that helps to stabilize the water rocket.

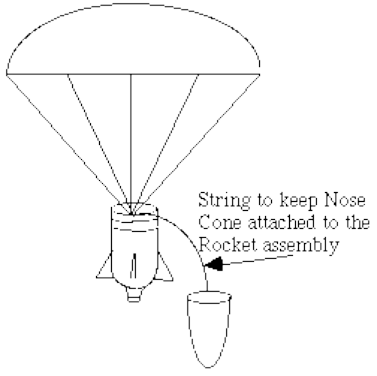


HOW IS A WATER ROCKET LIKE A NASA ROCKET?



ROCKET REQUIREMENTS

- Bottle Rocket 1
  - Must have a parachute to slow it down.
  - Looking for longest time in air.
- Bottle Rocket 2
  - Cannot have a parachute
  - Use alternate designs to slow it down.
  - Looking for longest time in the air.




The Sci Guys
SCIENCE AT HOME
WATER BOTTLE ROCKETS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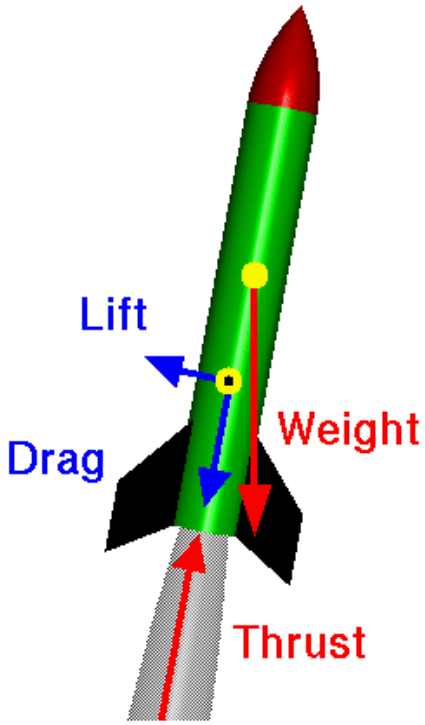
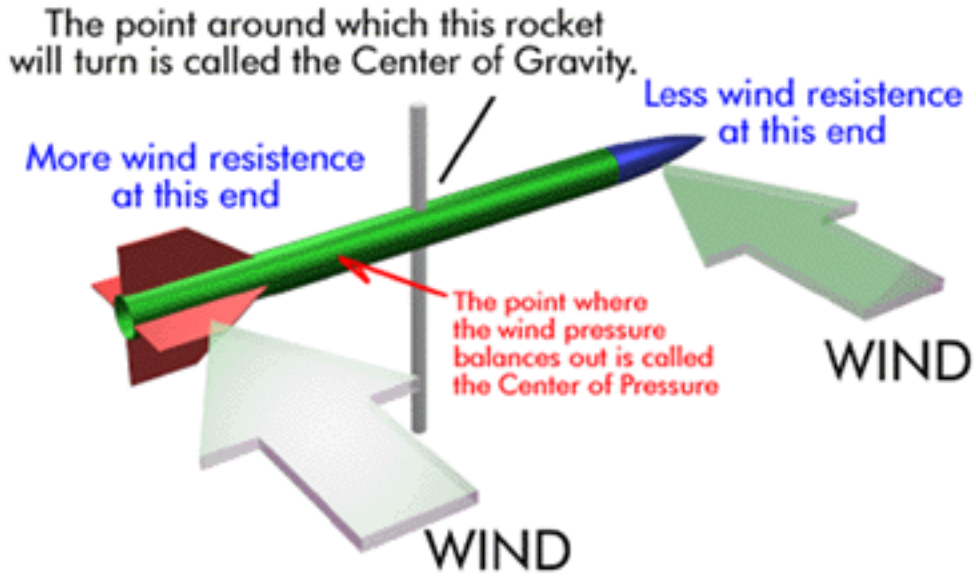
DESIGN CONSIDERATIONS



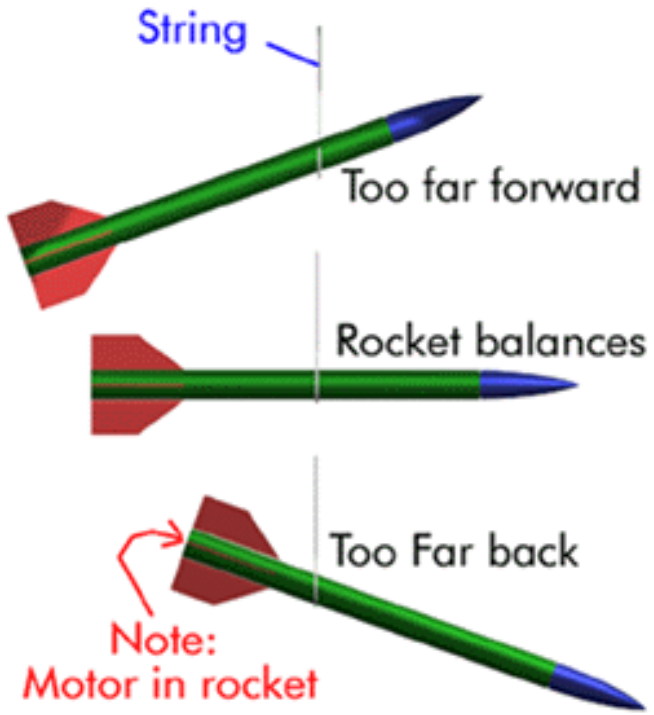
- There are 4 forces that act on a bottle rocket.
  - Weight
    - force generated by the gravitational attraction on the rocket.
  - Thrust
    - force which moves the rocket through the air, and through space. Thrust is generated by the **propulsion system** of the rocket through the application of Newton's third law of motion; *For every action there is an equal and opposite re-action.*
  - Lift
    - force which acts perpendicular to the direction of motion
  - Drag
    - force which is opposed to the direction of motion

CENTER OF GRAVITY

- As a rocket flies through the air, it rotates about a point called the center of gravity. The center of gravity is the average location of the weight of the rocket

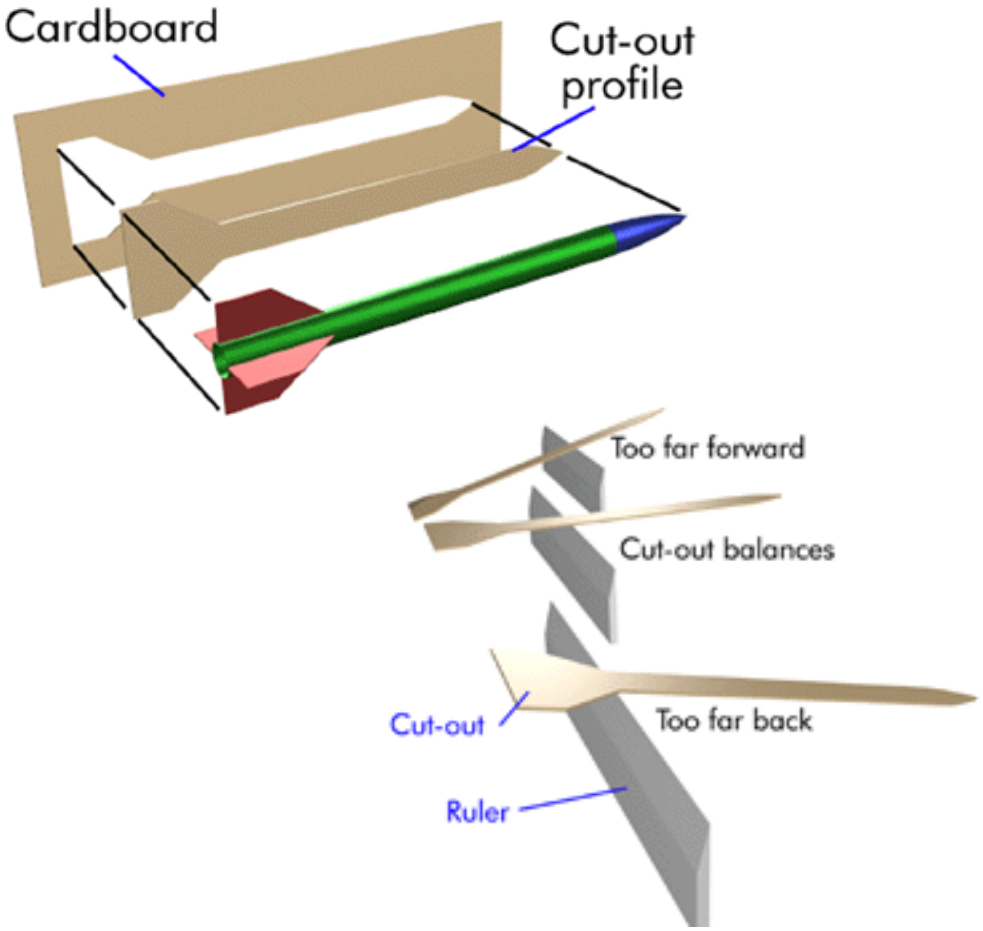


HOW TO FIND THE CENTER OF GRAVITY



- Put the amount of water in your rocket you will be using and tie a string around the middle. Move the string until your rocket balances.
- The point at which it balances is your Center of Gravity.

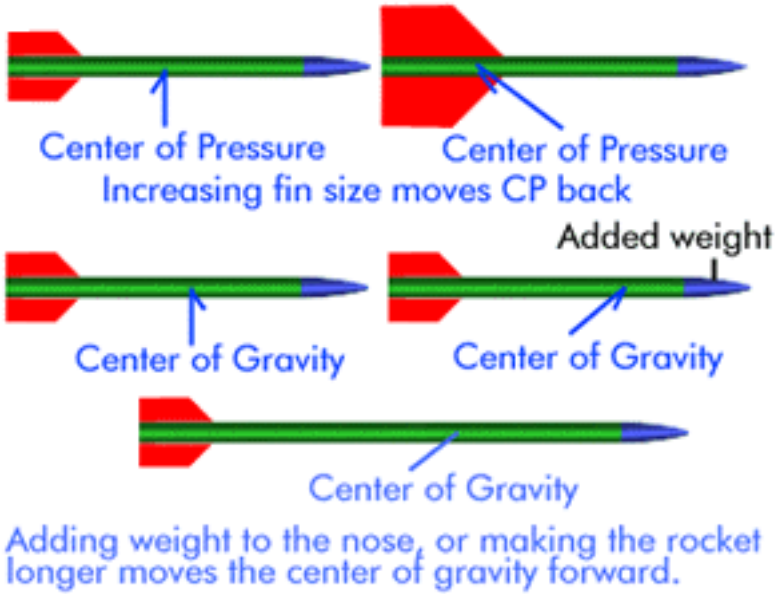
CENTER OF PRESSURE



1. Cut out a profile of your rocket in cardboard. It doesn't have to be the same size, but it does need to be accurate in shape and scale.
2. Balance the cut-out on the edge of a ruler. Mark where it balances. This spot marks the **Center of Pressure** of your rocket.

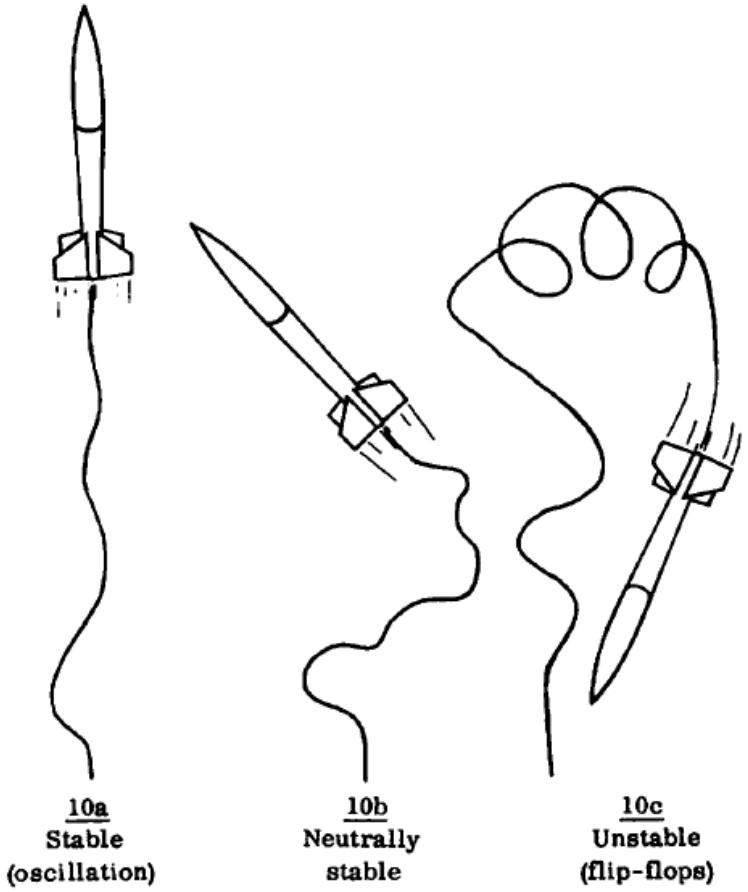
CENTER OF PRESSURE

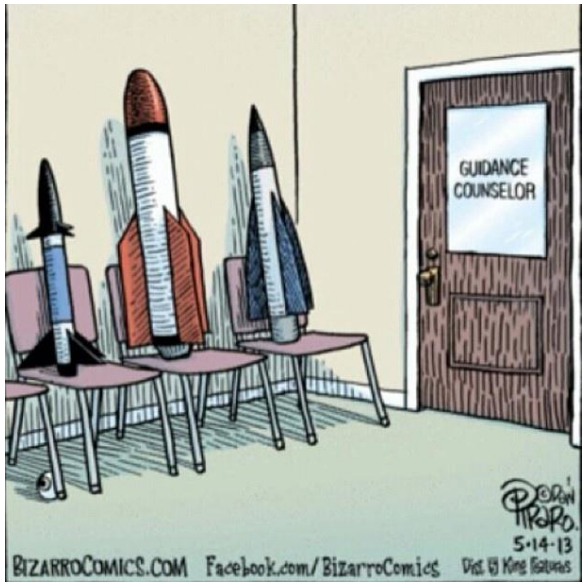
There is almost nothing you can do about your Center of Pressure other than to make your fins larger. The bigger your fins, the farther back the CP. You can more easily move your Center of Gravity by adding weight to the nose of your rocket, or making your rocket longer. This moves the CG towards the front. Ideally, you want your Center of Gravity to be one or two body tube diameters in front of your Center of Pressure. This is called one-calibre stability, and most rockets are close to this.



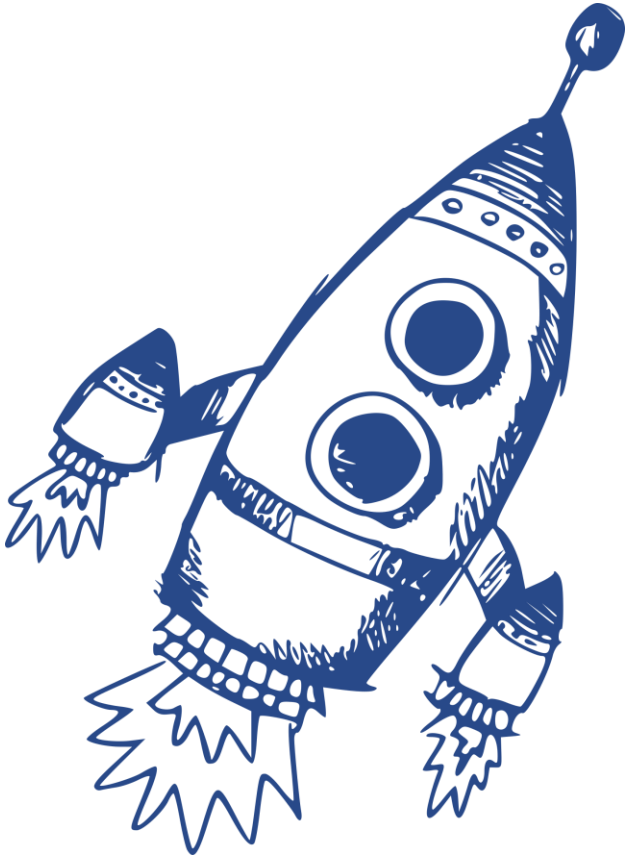
WHAT DOES IT MEAN TO BE STABLE?

- Stability:
  - the tendency of the rocket to return to equilibrium
  - This means if the rocket begins to veer, it will straighten back up on its own.
- To be stable, the center of mass must be closer to the top of the rocket than the center of pressure



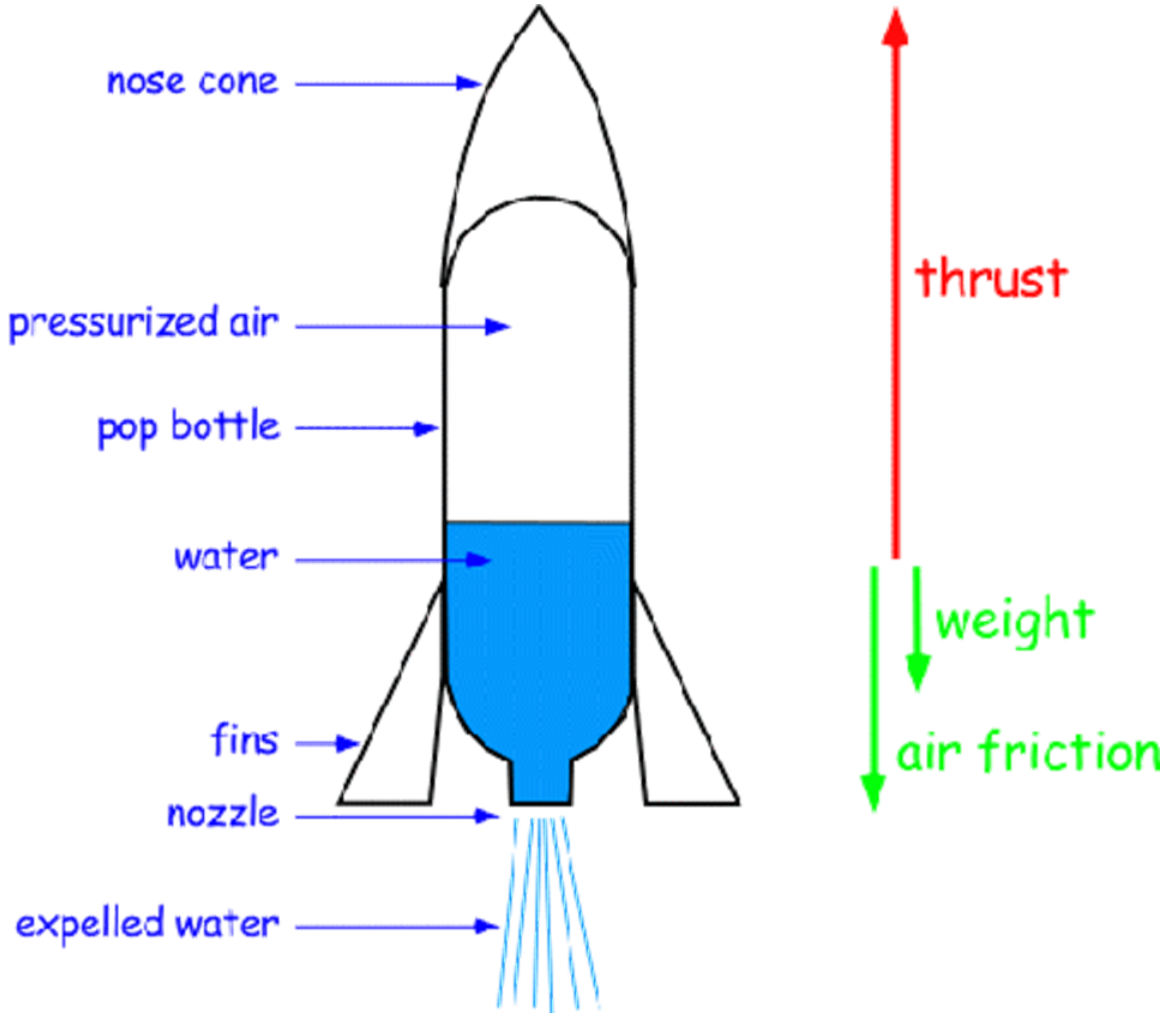


ROCKET PARTS



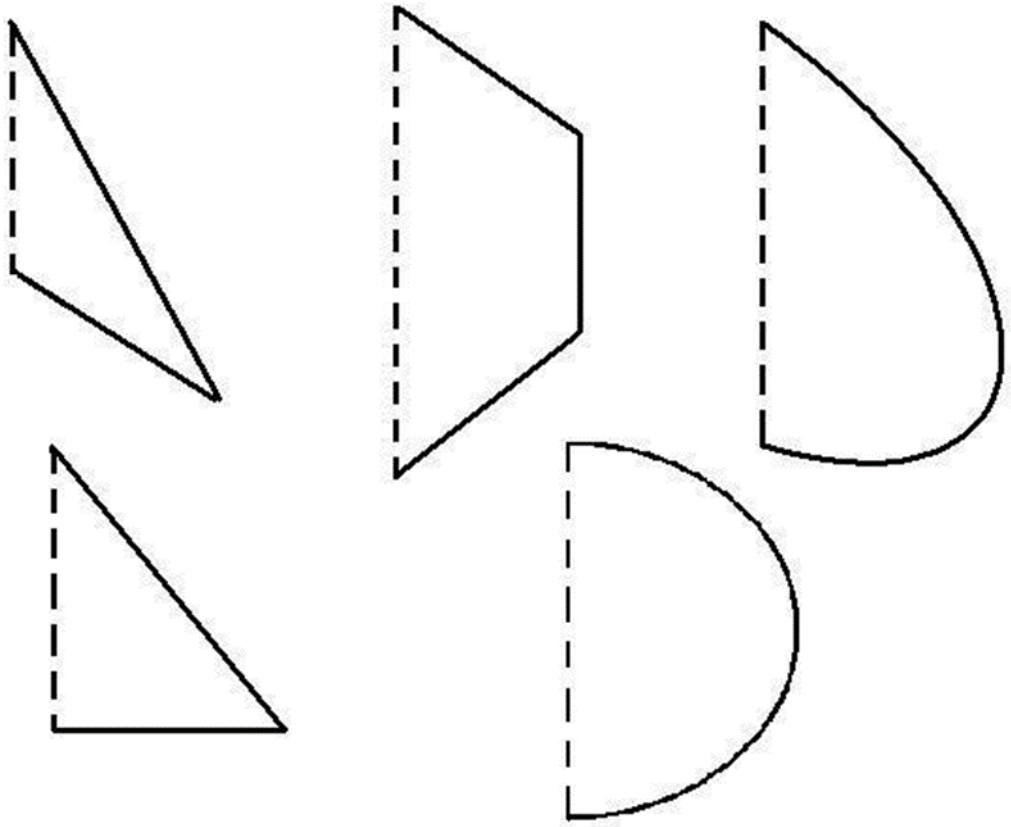
PRESSURE CHAMBER

- 2 Litter soda bottle
- Do not cut or scratch the pressure chamber.
- Can glue fins to pressure chamber with strong packing tape.
- If pressure chamber is damaged it will not be launched



FINS

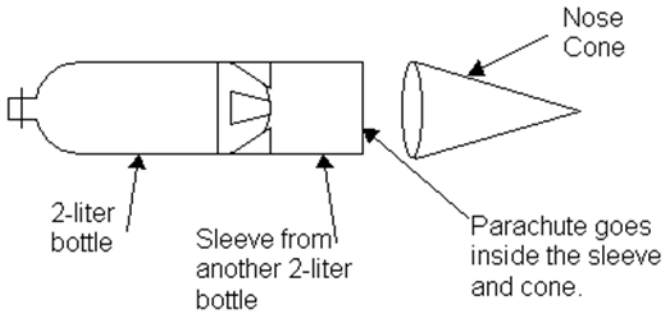
- Fins keep the rocket stable in flight
- Should be at least 3
- Fins should be rigid.

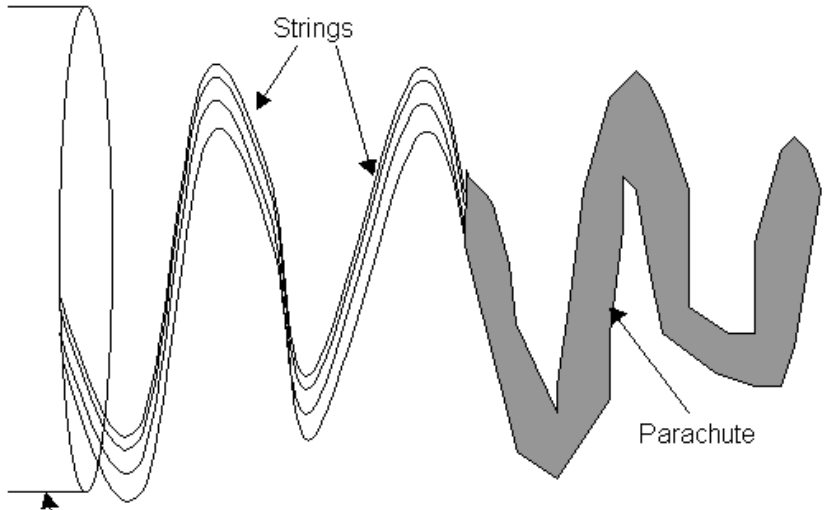


PARACHUTES

- A garbage bag parachute will do the trick
  - cut the bag, lay it flat
  - Attach strings so that they won't entangle and easily deploy
  - The better the parachute design the more time aloft your rocket will be.

Attach the parachute to the inside of the sleeve, underneath the nose cone as the following diagram indicates.





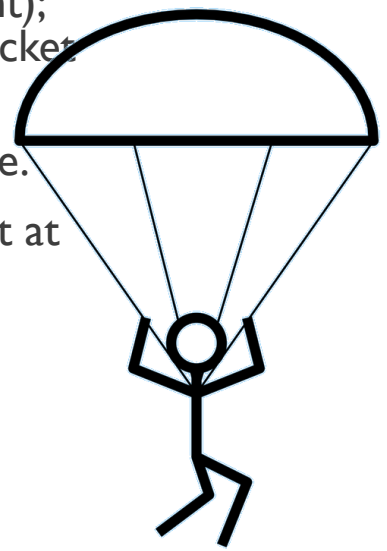
Do not wrap the string around the parachute!

PARACHUTES

The most difficult part of water bottle rocketry is not in the launch but in the deployment of the parachute. Around 90% of the rockets launched in class will not properly deploy the parachute.

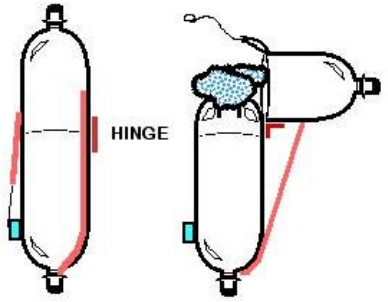
Design considerations:

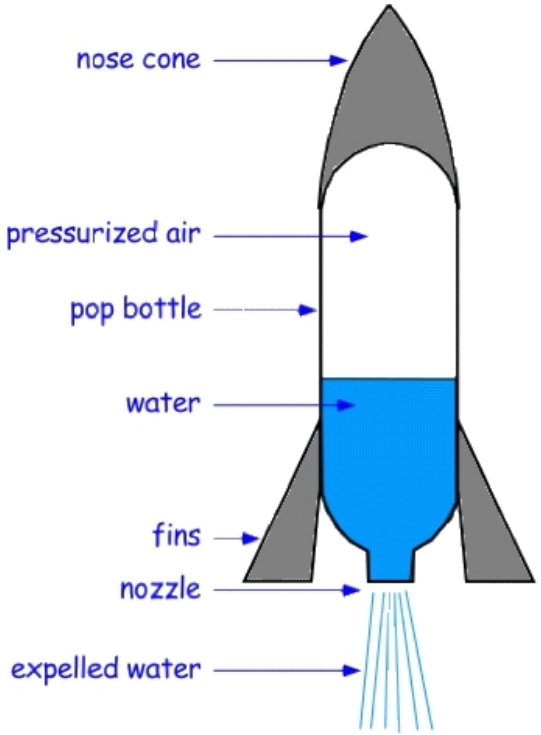
- Solid fuel rockets are entirely different than water bottle rockets. They use an "electric ZAP" to ignite the solid fuel rocket which propels the rocket upward. When it reaches its apex (top, or highest point of flight); the rocket engine creates a small upward explosion which pops the cone and chute out the top of the rocket tube. These solid fuel rockets are burned out and only used once.
- The problem with the water bottle rockets is the absence of the "pop" that ejects the cone and parachute.
- The main concept of water bottle rocket chute deployment is that the cone will separate from the rocket at the "apex" but not forcefully.
- Therefore the chute must be able to come out very easily.
- This can be attained by carefully packing the chute and connecting it properly to the separating cone. However most student's parachutes are stuffed in and require too much force to remove them and the gently separating cone usually does not succeed in fully deploying the chute.
- An alternate idea is to have a small preliminary chute which easily comes out of the nose cone and can act to pull out the remaining larger chute from the rocket body. (see drawings notes)



NOSE CONE

- The nose cone will help a rocket move through the air and help to control the path of its flight.
- How do you get the nose cone to separate from the rocket body? This could help to deploy a parachute to increase flight time.
- The nose cone must have a higher mass to surface area ratio than the body of the rocket. The nose cone must go through the air easier than the body of the rocket.
- Once the nose cone separates it must remain linked to the body of the rocket.
- The simplest nose cone for a bottle rocket is a paper cone taped to the top of the rocket. Made from cardstock or poster board, this nose cone is not durable, but does provide adequate aerodynamics.





BACKSLIDER

- This design allows your rocket to slow down without a parachute.
- Backslider is made by making the **center of gravity** close to the **center of pressure**
- This prevents the rocket from turning over at **apogee** and instead floating down on its side.
- Fins on this type of rocket should be larger to help slow it down.

BOTTLE ROCKET

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RESOURCES

- http://www.rocklin.k12.ca.us/staff/pmorrison/ConPhys/Rockets/Mr_%20Hayhurst%27s%20Quick%20and%20Easy%20Bottle%20Rocket.htm
- https://www.lcps.org/cms/lib/VA01000195/Centricity/Domain/3310/rocket%20measurement%20powerpoint.pdf
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