3, 2, 1, Blast Off!
Division A
2019

Event Description

Construct and launch two rockets designed to stay aloft the greatest amount of time.

- Failure to follow all construction rules will result in rockets not being allowed to launch due to safety issues or rockets being launched but placed in a lower tier
- Ranking within each tier is based on the greatest time aloft for one rocket flight
- Ties are broken based on the time aloft for the second rocket

Note: The pressure vessel must be made out of a single **2-liter** plastic carbonated beverage bottle.

Note: Free-Fall recovery systems (e.g., Parachutes) are allowed this year.

Rules, Rules, Rules

- Read the published rules
- Read them again
- Check for clarifications
- If anything in this presentation conflicts with the published rules, the published rules are what counts!!!
- Nobody running an event wants to eliminate a team based on rules violations, but we will if we have to.

Common Mistakes

1. Using the wrong size bottle. The pressure vessel must be made out of a single 2-liter plastic carbonated beverage bottle.
2. Forgetting the bottle labels, or using non-carbonated bottles – this is a safety violation and the rocket can't be launched
3. Using a bottle that does not fit the launcher. See the rules for guidance

More Common Mistakes

4. Inadequate testing prior to the competition – each test launch can be used to learn and to improve the rocket's design
5. Inadequate research – have the kids use the web to learn what will make their rocket fly high and land slow
6. Building the first rocket the night before the event (see items 4 and 5 above)

Major Design Decision

- Parachutes are allowed this year
- Should your team use a parachute? Factors to consider:
  - Parachutes are high reward and high risk
    - The winning team will probably have parachutes that deployed properly
    - Teams at the bottom of the rankings will probably have parachutes that did not deploy
    - Successful parachute deployment is difficult to achieve
  - Backslider rocket without a parachute is a common alternative design that is easier to develop successfully
  - Gliders are another alternative, either with fixed wings or wings that deploy at apogee.
- Whichever design the kids choose, they need to make sure they are compliant with all rules!

Making the rocket go higher

All rockets will be launched as 60 psi, so why does one rocket go higher than another??

- Maximize rocket stability so it does not wobble or tumble during ascent
- Reduce drag on the way up
  - Wrapping a parachute over the top of the rocket creates major drag!!
  - If the team is going to use a parachute, the kids should research options that will minimize the drag factor prior to parachute deployment
- Don't add weight for no purpose
- Optimize the amount of water vs air in the pressure chamber
  - What is optimal? That depends on the rocket. Fire your rocket design with different combinations to see what works best.

Rocket Stability

Factors to help ensure stability

- The center of gravity should be ahead of the center of pressure
- Proper fin placement

Centers of Gravity and Pressure

Center of Gravity should be above the Center of Pressure

- Center of Gravity (CG) - The center of gravity is weight driven. It is the point where half the weight is on one end of the rocket and half the weight is on the other end.
- Center of Pressure (CP) – The center of pressure is surface area driven. It is the point where half the surface area of rocket is one side and half is on the other. During flight, the pressure of air rushing past the rocket will balance half on one side and half on the other.

Finding Your Center

- Finding the Center of Gravity
  - Option 1 – Do complex mathematical calculations
  - Option 2 - Balance the entire rocket using a string to find the point at which the rocket is balanced
- Finding the Center of Pressure
  - Option 1 – Do complex mathematical calculations
  - Option 2 - Cut out the silhouette of the rocket from cardboard and balance it on a ruler

Fin Placement

- Fins must be attached with tape 5 cm or higher above the level of the bottle's opening
- Each fin should be same size and shape
- There are several recommended fin shapes – use test flights to evaluate which one works best with your design
- Fins should be evenly spaced around the pressure chamber. Measure circumference of the pressure chamber. Divide by the number of fins you are using. That is how far apart the fins should be.

Slowing the Rocket's Decent

- The rocket's decent is slowed by creating drag on the way down.
- How?
  - A properly designed backslider rocket will float down on its side, as opposed to nose diving.
  - A glider design will create drag with its wings
  - A parachute that deploys properly at apogee will catch air all the way to the ground

Preventing Nose Dives with Backsliders

There is no magic answer, but these suggestions may help

- Keep CG ahead of CP, but not too far ahead
- Try for as stable ascent as possible
  - Size the fins properly: not too big and not too small
  - Angle fins so that the rocket spirals during ascent
- Maximize the surface area of the upper tube
- Keep the rocket as light as possible

Parachutes

- Use the right size parachute for your rocket
- Fold the parachute like an accordion and then wrap extra string around it to keep it folded
- Use light, thin ply plastic (e.g., dry cleaning bag)
- Vent holes will reduce air spillage
- Parachute Strings
  - The parachute should have 8 to 10 strings
  - Light string work best
  - String length should be greater than diameter of the parachute
- Use baby powder to combat cling
- Investigate options for deploying the parachute from the rocket
- Research, design, test, improve, repeat!!

Useful Links

- NC Science Olympiad 3, 2, 1, Blast Off! event page
  https://www.sciencenc.com/resources/elementary/321-blast-off/
- Templates for the profile of a bottle (helps when making fins):
  http://www.waterrocketmanual.com/bottle_profiles.htm
- Making fins from a soda bottle
  http://waterrocket.uh-lab.de/pet_fins.htm

More Useful Links

- Parachutes http://www.uswaterrockets.com/construction_&_tutorials/Parachute/tutorial.htm
- Theory behind a glider rocket http://web.archive.org/web/20040417002013/http://members.aol.com/petealway/srrg.htm
- Making a cone http://craig-russell.co.uk/demos/cone_calculator/
- General build instructions http://projects.cbe.ab.ca/AlexFerg/showcase07-08/DynamicsofAir/bottlerocketinstructions.htm
- Launchers: http://www.nerdsinc.com/products/

Final Thoughts

Bottle Rockets is the best event in Science Olympiad. It can be a lot of fun and the kids will learn a lot, but only if they do the required researching, designing, building, and testing. Coaches should coach and make sure things are done safely, but it is important to let the kids do the work so they will learn.