

Bottle Rockets 2017

Division B



Disclaimers, Caveats, etc.

- Read and heed the OFFICIAL rules for this event.
 - Every effort has been made by the presenters to make sure that the information presented is accurate.
 - However, some, if not all, of the rules can and will be interpreted differently than what is presented here.
 - Do not “trust” any rules provided that you cannot verify that they match the official rule set published by the Science Olympiad organization for the current year (2016/2017).

Event Overview

- **DESCRIPTION:** Prior to the tournament, teams construct up to two rockets designed to stay aloft for the greatest amount of time while carrying a raw Grade A large Chicken egg that survives impact.
- **A TEAM OF UP TO: 2 IMPOUND: No EYE PROTECTION: B APPROXIMATE TIME: 10 min.**
- **EVENT PARAMETERS:** Teams must have eye protection and design, build, and bring up to two rockets to the tournament (only 1 launch per rocket). Parts from one rocket must not be used on another rocket. Event supervisors must provide the eggs (**one egg for each rocket**), launcher and water. Event supervisors will mark each egg to ensure that teams use the eggs provided.

Construction

- **CONSTRUCTION PARAMETERS:** Rocket pressure vessels must be:
 - Made out of a single one (1) liter or less plastic carbonated beverage bottle
 - The neck/nozzle opening will have an internal diameter of approximately 2.2 cm (a 1/2 inch Schedule 40 PVC pipe must fit tightly inside the nozzle opening).
 - Labels may be removed from the bottle but must be presented at the safety inspection.
 - *No label, no launch*

Construction, cont'd

- Only tape must be used to attach fins and other components to the pressure vessel. No glues of any type may be used on the pressure vessel.
- Glue may be used in other parts of the rocket assembly.
- Metal of any type and commercial model rocket parts are prohibited anywhere on the rocket.



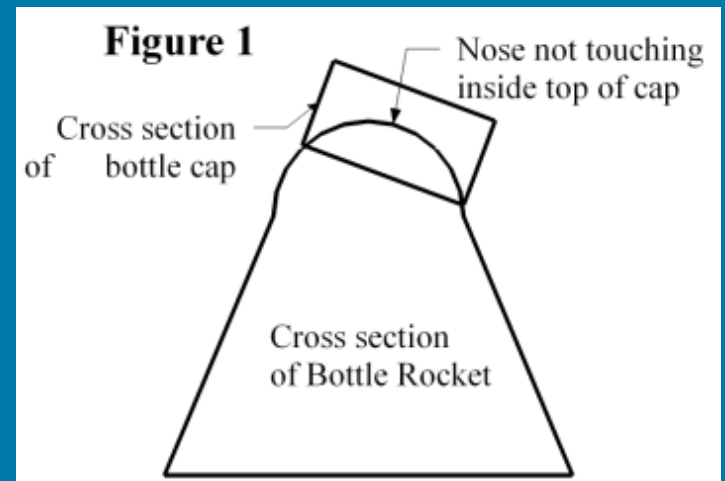
Construction, cont'd

- The structural integrity of the pressure vessel must not be altered.
 - This includes, but is not limited to:
 - Physical alterations (no cutting, sanding, etc.)
 - Thermal alterations (hot glues and other heat sources can weaken the bottle (pressure vessel))
 - Chemical damage/alterations (do not use solvents, super glues or spray paints on the pressure vessel).



Construction, cont'd

- Alteration to the structural integrity of the pressure vessel results in a safety violation of the rocket and it must not be launched.
 - Event supervisors assess structural integrity by looking through the nozzle and sides of the bottle for discoloration, bubbles, thinning or cuts in the walls.
- The nose of the rocket must be rounded at the tip and designed such that when a standard 1 liter bottle cap (~3.1 cm diameter x 1.25 cm tall) is placed on top of the nose, no portion of the nose touches the inside top of the bottle cap (see Figure 1).



Construction, cont'd

- Explosives, gases other than air, chemical reactions, pyrotechnics, electric or electronic devices, elastic powered flight assists, throwing devices, remote controls, and tethers are prohibited at any time.
- All energy imparted to the rocket at launch must originate from the water/air pressure combination.
- Fins and other parts added to the bottle must be 5 cm or higher above the level of the bottle's opening, to ensure rockets fit on the launcher (see Figure 2).

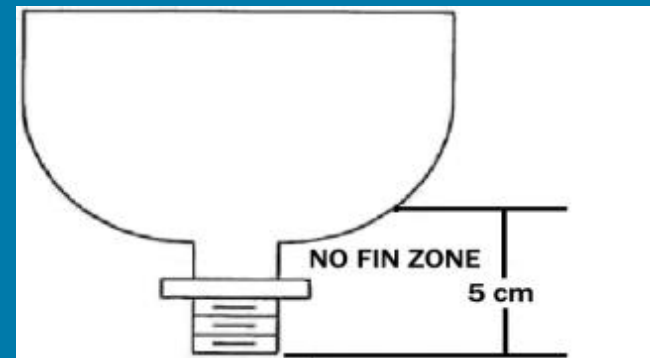


Figure 2

Construction, cont'd

- Rockets must **not** change shape or deploy any type of recovery system during launch or flight.
- Nothing (e.g., glue or tape) may adhere to the egg.



Design Considerations

Recovery Systems

- A recovery system is something that slows the rocket's decent.
- No recovery systems are allowed this year, so the rocket must be its own recovery system.

How to avoid a lawn dart – Backslider

- Making the Center of Gravity close to the Center of Lateral Area
- Center of Gravity - where the rocket balances
- Center of Lateral Area – where the shadow balances



Design Considerations

Stability

- A stable rocket tends to travel higher than an unstable rocket (obviously).
 - More height = more time aloft
- A stable rocket will have the Center of Gravity (CG) forward of the Center of Pressure (CP)
 - CP can be described as the point where a rocket would be balanced vertically, if held in a strong wind.
 - CP is not typically obvious to the builder, but an estimate of its location can be calculated using equations developed by James Barrowman
 - A good presentation for calculating the CP can be found at:
<http://www.rocketmime.com/rockets/Barrowman.html>
 - For a backslider, you would want to have the CG between the Center of Lateral Area (CLA) and the CP

Design Considerations

Ideas to increase time aloft

To slow down the decent, increase lateral area and decrease weight.

- – Use light materials (this includes tape)
- – Make the body wide
- – Use fins with large surface area

In a nose dive, the lateral area is smaller than when sideways, meaning a higher terminal velocity.



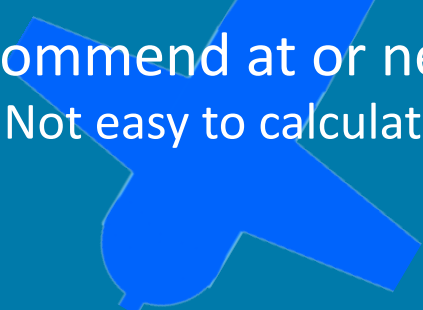
Design Considerations

- What size bottle should be used for the pressure vessel?
 - 1 liter
 - More water, more thrust
 - Larger bottle, more weight
 - 20 ounce and less
 - More slender than 1 liter
 - May not be able to provide enough thrust to lift egg?



Design Considerations

- Where should the egg be placed?
 - Tip of the rocket?
 - Meets the “blunt nose” criterion, but will make the rocket nose heavy ... splat
 - Top of the pressure vessel?
 - Might shift the Center of Gravity down too far
 - Could compensate by putting weight in nose
 - Somewhere in between?
 - Recommend at or near Center of Gravity
 - Not easy to calculate before assembly of the rocket



Design Considerations

- How do you keep the egg positioned properly?
 - For protection of the egg
 - For stability of rocket



Design Considerations

- How much water?
 - Could be dependent on the air pressure chosen by the Event Supervisor
 - Practice, practice, practice
 - Record the results of each flight and each combination
 - Practice some more



Competition

- **THE COMPETITION:**
 - All rockets must be launched using the launcher provided by the supervisor.
 - Following the safety inspection of the rockets, teams are allowed to inspect and select the eggs they will launch.
 - If a team breaks an egg before launch, they may request another egg but have a penalty of 10 seconds subtracted from their score.
 - Time begins when called to launch.
 - The team has a total of 10 minutes to add any amount of water to the inspected rockets, load the provided eggs, and launch the rockets (only 1 launch per rocket). Any rocket launched before the time expires must be scored.

Competition, cont'd

- Rockets must be launched at a **minimum of 45 psi and a maximum of 60 psi.**
- **Launch psi must be the same for all teams and will be announced at the beginning of the competition.**
- Once pressurized, teams must not touch or approach the rocket.



Competition, cont'd

- Time aloft is recorded in hundredths of a second.
- Timing begins when the rocket separates from the launcher and stops when any part or piece of the rocket touches the ground, goes out of sight, or is **slowed by** an obstruction (e.g. a tree or building).
- Event supervisors are strongly encouraged to use three independent timers on all launches.
 - The middle value of the three timers must be the officially recorded time.
- Teams must retrieve their rockets and remove the egg in the presence of the event supervisor.

Scoring

- **SCORING:**

- Rockets in violation of rules 3.a-f will not be launched due to safety.
- Teams that are unable to launch **both** rockets because of safety violations will receive participation points only.
- **Any rocket that violates construction rule 3.g-i or has a competition violation will receive a launch time of zero for that rocket.**
- **An irretrievable rocket will be scored as if the egg did not survive.**
 - Survival is defined as an egg leaving no wet spot on a paper towel.

Scoring, cont'd

- Ranking within each tier is determined by the highest combined time aloft for both rockets:
 - Tier 1: Launches with 2 surviving eggs
 - Tier 2: Launches with 1 surviving egg
 - Tier 3: Launches with no surviving eggs.
- Ties within Tiers:
 - Tiers 1 & 3 ties will be broken by the greatest time aloft by a single rocket
 - For Tier 2, ties will be broken by the surviving egg's rocket greatest time aloft.

Resources

- **Recommended Resources:**

- All reference and training resources including the Bottle Rocket DVD are available on the Official Science Olympiad Store or Website at <http://www.soinc.org>
- Additional resources are available at <http://www.scioly.org>
- Bottle Rocket Handbook at <http://www.leosingleton.com/archive/handbook.pdf>