Rocket Design Report

The Violette 3000

January 22, 2015

Question

The purpose of this lab was to successfully build a rocket out of water bottles and get it to fly its maximum distance. If the students chose to do so, they could use more than one bottle and create a multi-tank rocket. The rocket would eventually be powered by water and pressure. To make sure that the rocket flew a far distance, it must have been the correct weight, been aerodynamic, and have correctly spaced wings. Types of bottle brands react differently under pressure as well. After multiples days to test the rockets, the students put together the information that they gathered and built the best possible rocket.

Background

Before building the first rocket, research was done on how to build a basic bottle rocket. One of the most helpful ways to do this was to read past lab reports from last year's students[1]. They included details about which materials worked or didn't work for them and provided tips on which designs were the most successful. A couple other websites were helpful as well. The Natural Philosopher's website[2] was useful for getting a general introduction on building the rockets, as well as the U.S. Water Rockets[3] website to get specific details and steps on building each part of a rocket.

The materials used for the rocket included two Smart Water bottles, one and a half golf balls, a half of a plastic Easter egg, cardboard, scissors, a knife, sandpaper, mineral spirits, super glue, duct tape, foam, and water.

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[1] "FlyRocketFly." *FlyRocketFly*. N.p., n.d. Web. 21 Jan. 2016.
[2] "Galway Rocket Day." *Galway Rocket Day*. N.p., n.d. Web. 21 Jan. 2016.
[3] "How to Make High Pressure Water Rockets Part 2." *U.S. Water Rockets*. N.p., n.d. Web. 21 Jan. 2016.

The first step in assembling the multi-tank rocket was splicing two bottles together[4]. Smart Water bottles were recommended by Amy Engel in her lab report from last year[5]. These bottles are ideal for the rocket because their smooth surface and long shape can create an aerodynamic rocket that can fly further than the two liter bottle ones. To begin splicing the bottles they first needed to be cut and cleaned. The bottom of one bottle and the top of the other were cut and the labels were removed. Mineral spirits helped to remove any excess stickiness. One bottle needed to be shrunken a tiny bit just so that it could fit into the other bottle tightly. To shrink it, about an inch of water was heated to 160 degrees fahrenheit. Then the cut end of one of the bottles was placed in the water for a few seconds. The ends that were being put together were then sanded and glued with superglue.

The general idea for the Easter egg nose cone came from the U.S. Water Rockets website[6]. The shape of the egg makes an aerodynamic nose cone. Foam was glued inside to absorb the shock from the landing and a half of a golf ball was added to give it weight in the front, which would help to propel the rocket. The egg was then glued onto the top of one of the bottles. A full golf ball was glued into a piece that had been cut from the original bottle and this was super glued into the top of the bottle where the nose cone was before they were spliced together. This was meant as a way to add more weight to the front.

[4] "How to Build a Spliced Bottle Water Rocket." *Tutorial 6: U.S. Water Rockets Slip Joint Bottle Splicing.* N.p., n.d. Web. 21 Jan. 2016.
[5] "2015 - A1 - Amicus Engel - FlyRocketFly." *2015 - A1 - Amicus Engel - FlyRocketFly*. N.p., n.d. Web. 21 Jan. 2016.
[6] "How to Construct a Water Rocket Nosecone." *How to Construct a Nosecone For a Water Rocket.* N.p., n.d. Web. 21 Jan. 2016.

The Box Fin design was also taken from the U.S. Water Rockets website[7]. They are quick to make and easy to assemble. They were designed to be more durable than other fins. Their hexagonal shape, shown in Figure 1, make them easy to accurately align. Making sure the fins are perfectly aligned is important for creating a rocket that can fly accurately and remain stable while it is in the air. Using the pattern from the Water Rocket website, three fins were cut from cardboard and then they were reinforced with duct tape. The edges were connected and wrapped around the bottle, then glued in place.

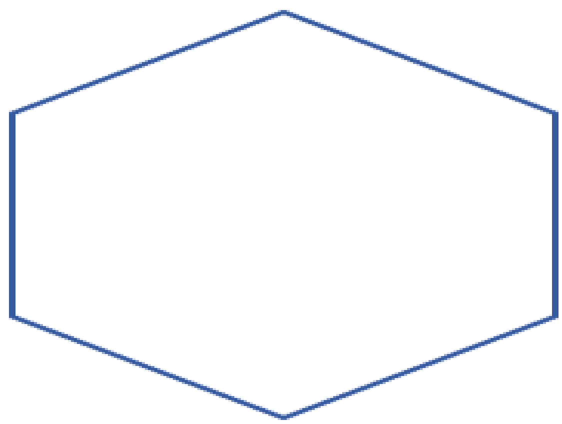


Figure 1: Box Fin

The completed rocket was reinforced with duct tape around the nose cone and around the splice. Figure 2 showed a diagram of the completed rocket, named the Violette 3000. Figure 3 shows a picture of it.

[7] "Building Removable Water Rocket Box Fins." *Tutorial 9: How To Build Removable Box Fins for Your Water Rocket.* N.p., n.d. Web. 21 Jan. 2016.

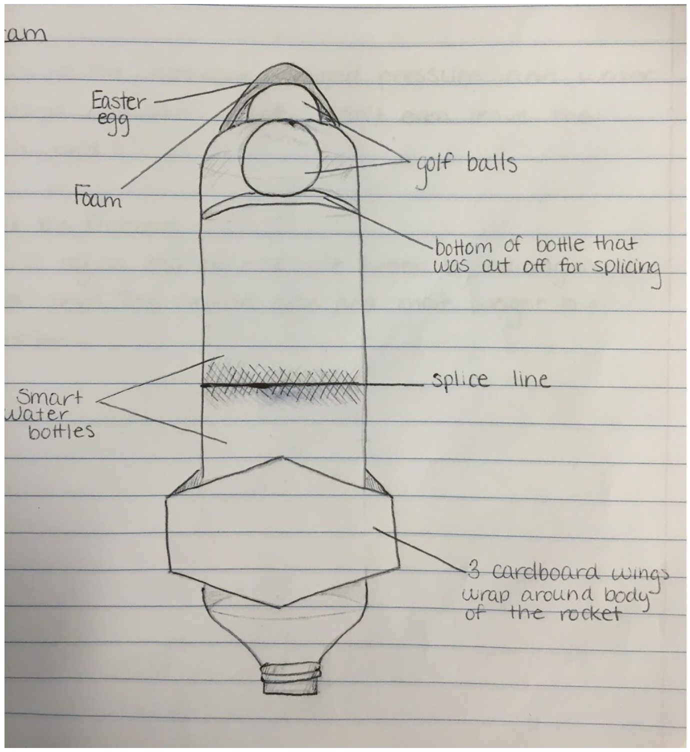


Figure 2: Violette 3000 Diagram

Figure 3: The Violette 3000

Experiment and Analysis

Launch Round	PSI	Distance (yds)
1	60	0

Figure 4: Launch Day 1
9/22/15

The goal of the first launch was to see if the spliced bottles would hold together and see if the wings would provide enough stability. However, a leak in the nose cone caused pressure and water to escape and he rocket wasn't able to leave the launch pad. For the next launch, resin was tested as a way to better seal the nose cone as well as add more weight to the rocket.

Launch Round	PSI	Distance (yds)
1	80	0

Figure 5: Launch Day 2
9/30/15

The goal of this launch was to test to see if the nose cone would be completely sealed by adding a layer of resin with duct tape over it. While the nose cone held up under the pressure, the splice broke and and rocket split in half. For the next launch, a new rocket was built using the same materials but a stronger glue on the splice.

Launch Round	PSI	Distance (yds)
1	80	0

Figure 6: Launch Day 3
10/2/15

In order to test the way the splice would hold during this launch, two bottles were spliced together with Gorilla Glue Epoxy. This type of glue was recommended by Roselyn Palaszewski and Luke Burgess and had been successful for them. Instead of Smart Water bottles, Seltzer bottles were used instead because there were no Smart Water bottles were available at the time that the rocket was made. The bottles were glued and spliced using the same steps as before but because just the splice was being tested, no wings or nose cone were added to it. When the rocket was put on the launch pad, the glue held as the splice but the bottles themselves ripped. After this trial, only Smart Water bottles were used.

Launch Round	PSI	Distance (yds)
1	130	28
2	130	50
3	138	25

Figure 7: Launch Day 4
10/8/15

This rocket was constructed in the same way as the previous one, using Gorilla Glue Epoxy and following the same steps as before but with Smart Water bottles instead of Seltzer bottles. The bottles were spliced but no fins or nose cone were added. The launches were successful and the rocket was ready to be completed for the next launch.

Launch Round	PSI	Distance (yds)
1	138	196
2	138	203

Figure 8: Launch Day 5
10/14/15

Launch Round	PSI	Distance (yds)
1	139	179
2	139	187

Figure 9: Launch Day 6
10/20/15

Launch Round	PSI	Distance (yds)
1	138	169
2	138	150
3	138	175

Figure 10: Launch Day 7
10/22/15

Launch Round	PSI	Distance (yds)
1	138	175

Figure 11: Launch Day 8
10/30/15

For Launches 5 through 8, the rocket held up and flew well. The goal was to see how long it could be pushed before breaking and it worked every time. The fins and nose cone were cut off of the first rocket and glued onto the newer one using Gorilla Glue Epoxy.

Launch Round	Rocket	PSI	Distance (yds)
1	Violette 3000	138	164
1	Violette 3001	138	203
2	Violette 3001	138	175

Figure 12: Launch Day 9
11/5/15

Using the leftover materials from building the previous rockets, a new one was built as a backup for Rocket Day since the older one was starting to become very beaten up. It was named the Violette 3001 and was built with three bottles instead of two, but the method of splicing was the same as before. One slight difference was that the golf ball in the nose cone was surrounded with clay rather than foam, giving it just a bit more weight in the front. The wing design was also changed as well. Each fin was a parallelogram cut from cardboard and covered in duct tape to reinforce it. This design replaced the box-fin one and was inspired by Roselyn and Luke. A diagram of the completed rocket is pictured below in Figure 13.

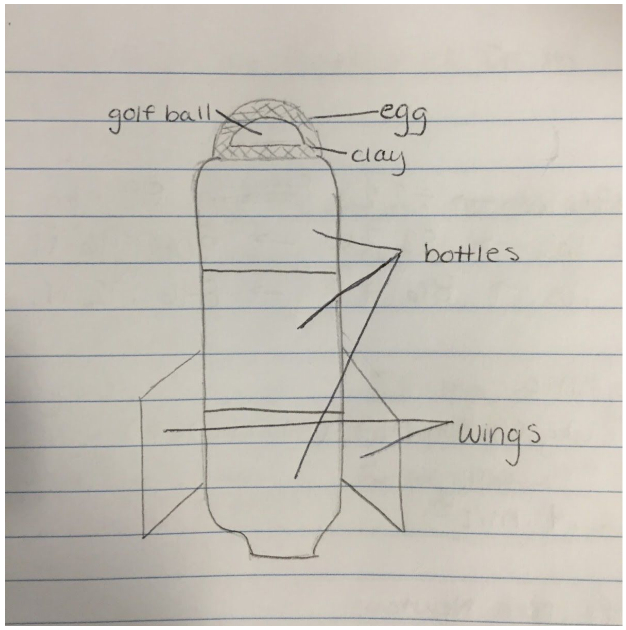


Figure 13: The Violette 3001 Diagram

After the first round of flying rockets, the Violette 3000 was taken out because it was beginning to show signs of weak spots from all of its uses and it still needed to last until Rocket Day. The newer rocket held up well and flew very steadily.

Launch Round	Rocket	PSI	Distance (yds)
1	Violette 3000	138	175
1	Violette 3001	138	227

Figure 14: Rocket Day
11/7/15

Rocket Day was successful. The goal was to see if the improvements on the rockets had worked and they would fly their best yet. Both rockets flew well, however the older one was barely being held together. The Violette 3001 was very successful and went one of the farthest distances of the day.

Conclusion

When constructing a multi-tank rocket, the hardest part to assemble is the splice between the two bottles. Having the right glue is extremely important to making sure it will hold up under the extreme pressure. When applying the glue, one must make sure they apply it to the surface as evenly as possible and wait the amount of time that the package suggests before handling the rocket. When splicing the bottles, it is also important to sand them well and remember to put one in heated water in order to shrink it so that it will fit inside the other one.

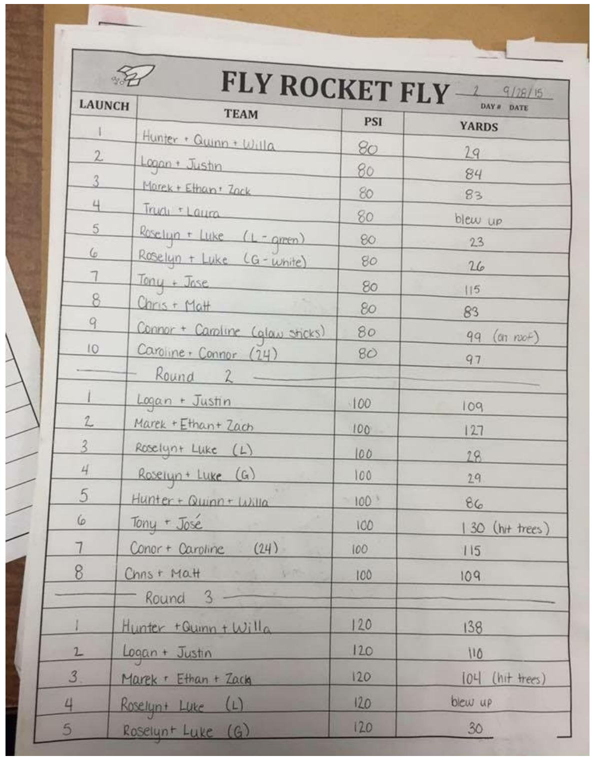
The final design, which is shown in Figure 13, was the most successful. The materials that were used were three Smart Water bottles, Gorilla Glue Epoxy, a half of a golf ball, a half of a plastic Easter egg, duct tape, clay, and cardboard. The three bottles were spliced together using the method from the U.S. Water Rockets website[8]. The fins were three parallelograms cut from cardboard and reinforced with duct tape. They were spaced evenly around the bottom of the rocket and attached with duct tape. The nose cone was made of a plastic Easter egg. The inside had a layer of clay with a golf ball packed tightly inside. This added the needed weight in the nose cone. This was then glued on the top of one of the bottles and reinforced with duct tape.

When constructing a multi-tank bottle rocket, make sure that everything is done precisely. Splice the bottles carefully and correctly. Put more weight in the front. A top heavy rocket will tend to propel further. Double check to make sure the wings are evenly spaced. This will help to keep the rocket from spinning to much as it flies. Don’t get discouraged if it doesn’t work on the first try, eventually the right design will be achieved.

Launch Team

The scribe is in charge of keeping track of data while the rockets are launching. They need to have a clipboard, charts, and a pen or pencil with them. They make sure that everybody knows what the launch order will be and they let people know when they are up next so they can be prepared with their rocket. The scribe records the launch round, team, PSI, and the distance each rocket has flown.

[8] "How to Build a Spliced Bottle Water Rocket." *Tutorial 6: U.S. Water Rockets Slip Joint Bottle Splicing.* N.p., n.d. Web. 21 Jan. 2016.



FLY ROCKET FLY 2 9/28/15
DAY # DATE

LAUNCH	TEAM	PSI	YARDS
1	Hunter + Quinn + Willa	80	29
2	Logan + Justin	80	84
3	Marek + Ethan + Zack	80	83
4	Trudi + Laura	80	blew up
5	Roselyn + Luke (L - green)	80	23
6	Roselyn + Luke (G - white)	80	26
7	Tony + Jose	80	115
8	Chris + Matt	80	83
9	Connor + Caroline (glow sticks)	80	99 (on roof)
10	Caroline + Connor (24)	80	97
	Round 2		
1	Logan + Justin	100	109
2	Marek + Ethan + Zach	100	127
3	Roselyn + Luke (L)	100	28
4	Roselyn + Luke (G)	100	29
5	Hunter + Quinn + Willa	100	86
6	Tony + José	100	130 (hit trees)
7	Conor + Caroline (24)	100	115
8	Chris + Matt	100	109
	Round 3		
1	Hunter + Quinn + Willa	120	138
2	Logan + Justin	120	110
3	Marek + Ethan + Zach	120	104 (hit trees)
4	Roselyn + Luke (L)	120	blew up
5	Roselyn + Luke (G)	120	30

Figure 14: Scribe Data Table

During the launch, a scribe will let the other people know when they will be launching their rocket soon, They keep track of all the data and help to keep things organized and running smoothly.