Fly Rocket Fly

Radical Putin Ideas

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Question: What is the best way to design a bottle rocket in such a way where it both travels a long distance and survives multiple launches?

Background: The designs of the previous years were examined in order to see what worked well, and what didn't. Most of the rockets were single tank designs, with large cardboard fins. The large fins allowed for the previous rockets to be very stable and travel large distances. However, last year a multi tank rocket was very successful. The bottle was created using multiple Smart Water Bottles, duct tape, glue, and cardboard fins. This was the first successful multi tank design in the class, because they are very hard to make. The seals break easily when pressurized, causing the rockets to blow apart. The multi tanks were able to go farther because they had more power. The difference between the distances generally traveled by the two types of rockets suggested that if the extra power could be given to a shorter rocket, it might travel very far. It was decided that a multi tank rocket made of two large lemonade bottles would be best, combining the extra strength of the multi tanks with the relative shape of the single tank rockets. In theory, the extra capacity of of air and water would allow for the rocket to have more power in a smaller shape, compared to the length of the previous multi tanks, which had added weight and were less aerodynamic.

Experiment: Two lemonade bottles were cut in half. The bottles were each two liters in volume. They were sealed together in such a way, with the top of one bottle serving as the tail, and the bottom of the other bottle serving as the nose. The leftover mouth was used as the actual nose cone. A stopper was placed in the mouth, so that the weight wouldn't escape. Thumb gum was used to weigh down the nose cone. The fins were cut out of a plastic bucket and glued on the rocket in such a way they they would cause the rocket to spin, in the same way that a bullet spins as it travels through the air. This was an attempt to add extra stability to the rocket as it flew through the air. The extra stability would, in theory, allow for the rocket to travel farther. Everything was glued together using an industrial strength epoxy. The epoxy was fast acting, meaning that once mixed, it would harden in approximately ten minutes.

In the first experiment, with 60 psi, the nose of the rocket separated from the tail. The distance that the nose traveled was, unfortunately, not recorded. A new single tank rocket was designed. This would fill time while we make the final design. It also provided an opportunity to see how durable a rocket can be and how far it can be consistently launched. This rocket came back from multiple launches with dents and deformities. The rocket began to develop a very large dent towards the center. With each launch, the dent got larger and larger. Despite this, every launch when the air went in, the rocket would expand back to its original shape, and fly as it always had. The following is a table of the flight of the single tank rocket. The final design involved using five Mountain Dew bottles to create a long multi tank rocket. The bottles were sealed together using the same industrial strength epoxy as the previous rocket. This time, however, extra layers of plastic were added, so that there were layers. The bottom layer was the two bottles glued together. Then a plastic strip from a larger, two liter Pepsi bottle was glued over each of the seals. Rubber bands were used to hold the strips onto the rocket during the gluing process. The rubber bands could not be removed without damaging the seals, so they were left there. The rocket at this stage is pictured to the right. Then to add an extra layer of protection, we sealed fiberglass over the shaft with resin. The resin was fast acting, just as the epoxy was, so the work had to be done quickly, but carefully. Any air bubbles in the fiberglass would endanger the rocket's stability. The fins were attached using the industrial strength epoxy. They were three squares, stapled together in a triangular way.

The Final Rocket before the fiberglass was added

Analysis: The first rocket performed better than the multi tank rockets ended up performing. It had the maximum distance of all the rockets. However, it was very inconsistent in, and didn’t travel as far as the multi tank rocket in a few trials. The multi tank rocket only had one test, due to an unfortunate malfunction. There was a leak somewhere in the shaft of the rocket. The pressure built up until finally the rocket burst. The fiberglass, along with three of the bottles soared away. The flight was extremely stable, however the nose cone was broken in the end.. The remaining two bottles remained on the launcher, with a massive dent in them. The pipe on the launcher was severed by the event.

Table 1: Single Tank Rocket

Test Number	**Psi**	**Distance (yards)**
1	80	83

2	100	109
3	120	46
4	130	126
5	100	103
6	138	130
7	138	80
8	138	140

Table 2: Multi Tank Rocket

Test	Psi	Distance
1	138	126

Conclusion: In the end, the single tank rocket was the only rocket to survive multiple tests. The other two rockets broke upon launch. The fiberglass failed in doing its intended purpose. This doesn't mean that it will always fail, however. If done differently, it's entirely possible that the rocket would survive multiple trials. In the future, it could be done again with more care given to eliminating all the air holes and possible leaks in the seals. The fiberglass does have one major problem, that can break its usefulness. The fiberglass is heavy. When flying through the air, the fiberglass slowed to a halt, and then promptly plummeted to the ground. The weight was tremendous enough that it could have been the possible cause of the destruction of the nose cone. However, the damage could have occurred when the air began to leak. It was possibly even a combination of the weight and damage caused by the air leak. Nevertheless, this proves that ultimately the fiberglass and resin fails to protect the seal of a long multi tank rocket. Perhaps when attempting to properly seal the fiberglass with resin, it could be attempted on a smaller multi tank rocket, similar to the first one. The smaller surface area would lead to less weight and compacting the weight into a smaller space could cause the rocket to enact more force upon launch. It is also worth noting that the fiberglass itself did not break. Since the damage clearly occurred in the individual seals of the bottles, it could be possible to seal the bottles using only fiberglass and resin to prevent that problem.

The single stage rocket behaved very interestingly. The rocket wasn't consistent across every psi, or even every day. The rocket's shortest distance was at 120 psi. This could be attributed to the wind, the damage done to the rocket at that point, or even the placement on the launcher. That test is easily explainable. The far more interesting tests were the final two. In the seventh test, the rocket only traveled 80 yards, the lowest since the aforementioned 46 yard flight. Then in the very next test, which occurred on the same day, only minutes later, the rocket traveled 140 yards, the farthest distance of all. At this point the rocket had survived damage from seven other launches. Nothing was done to modify the rocket between the seventh and eighth launches. It is highly unlikely that the wind completely switched direction in the time between the two tests. Another reason is that the tail was dented, probably only slightly, by the various landings that the tail bent slightly in a certain direction. The rocket was not consistently placed on the launcher in the same position, leading to the dent affecting the flight path of the rocket and therefore the distance. The fin design could also have had an effect. The fins were meant to cause the rocket to spin in order to be more stable. Instead, the opposite occurred. The rocket's flight was very unstable and inconsistent. If different fins were in different spots relative to the ground each time the rocket was placed on the launcher, then this could have affected the flight path. The flight path could also have been affected by the presence of wind as well. The rocket's peculiar path through the air could have been more susceptible to wind resistance. The 80 yard launch could have been in the presence of wind, while the 140 yard launch may have had no wind at all.

In the end, the fin design was a total and complete failure. It only hindered the rocket's flight instead of helping it. The fiberglass and resin failed at holding the rocket together and proved to be too heavy to travel very far. In the future, larger, cardboard fins may be the best option for fins, and epoxy and duct tape is the best option to seal multi tank rockets.