**ENGR 112**

**Water Rocket Project**

**Spring 2018**

**Brief Description and Problem Statement**

We were tasked with the construction of three rockets by the due date May 3. The rockets must carry a payload and use pressurized air and water to generate a change in momentum and achieve liftoff. Before the physical experiment, a VBA subroutine must be coded to model our rockets’ flights. After, simulating projections in excel, the construction phase will commence. Building begins initially on paper. Drawings of the fins and top with precise scale measurement are drawn before moving on to the careful assembly of the rocket.

**Description of Rocket With As-Built Drawings**

Figure 1 outlines the detail of rocket design. For each rocket there are two empty 2-L Pepsi bottles. (The plastic cap ring from the outer neck of the bottle is removed but keep one bottle cap). The neck of one bottle is cut to create a hole that is about 1.5 inches in diameter. Then the top off of this bottle is cut where the cylindrical portion intersects with the round top. This part is secured using appropriate adhesive to the bottom of the other bottle leaving about 2 inches of space between the bottom of the bottle and the 1.5 in hole as shown in Figure 1. The void space between the rounded nose and the bottle bottom holds the payload (a quarter). To keep the quarter from falling out the void space is filled with polyester filler and the hole is covered with tape.

The rocket has three fins secured using appropriate adhesive on it spaced 120 degrees apart. The fins attach starting where the surface of the bottle is no longer rounded and continue 5 inches up. The bottom tip of the fin is 5 in from the the center of the bottle (2.85 inches from the flat surface) and 2 inches below the lowest point of the bottle (6 inches below the first contact point of the fin to bottle and 11 in below the top of the fin) as shown in Figure 1. The diameter and height of the bottleneck is 0.842 inches and 0.90 inches respectively. The total height of the rocket is about 17.23 inches and the total width is about 8.82 inches.

Figure 2 shows a schematic representation of the water rocket. The different mass variables are identified with the total mass being the sum of the masses. The force of thrust acts only during the ascent and in the positive direction. The force of drag acts down during the ascent and up during the descent. The force of gravity acts on the rocket during the entire price and is always in the negative direction. The view from above is also given showing that the radius of the bottle at its max is 2 in and that each fin protrudes 2.85 inches from the outer edge of the bottle.

**Operating Procedures**

Fill the bottle with the amount of water shown in Table 1, where the fill fraction f is defined as follows: empty volume of bottle volume of water f = (volume of water) / (volume of empty bottle). To ensure the water does not leak out, secure the cap on the bottle. Bring the water-filled bottle rocket to the launch site.

Setup

1. Secure base to ground using stakes

2. Attach quick connect

3. Remove wing nuts

4. Adjust bolts to level RLA

5. Install appropriate launch tube

Launch

1. Place the quarter in the nose-cone and fill the void with fiberfill.

2. Remove the RLA from the base.

3. Remove the cap from the bottle. Invert the RLA and insert it into the bottle. Ensure that the O-ring seals the neck of the bottle.

4. Rapidly invert the bottle and place the RLA on the base.

5. Move the lanyard so it holds the neck of the bottle onto the O-ring.

6. Ensure that everyone is wearing safety goggles and is at least 10 feet from the bottle.

7. Pump the bottle to a pressure of 100 psig.

8. Shout “Fire in the hole.”

9. Ensure that no one is within 10 feet of the launch pad.

10. Pull the lanyard and watch the rocket fly.

11. Recover the rocket.

Takedown

1. Remove stakes

2. Detach quick connect

3. Secure RLA to base using wing nuts

**Safety Measures**

During the building process we used the proper precautions when handling the X-Acto knife and adhesives. During launch we will wear safety goggle and make sure everyone is at least 10 feet from the launch pad.

**Expenses**

**Item…………………………………………………………………………………………..Cost**

6 2-Liter Pepsi Bottles………………..……………………………………….….………$10.74

Fin Material (cardboard).…………………………………………………………………$0.00

Polyester Fiberfill……………………………………………………….…………..…….$9.99

Paper Towels……………………………………………………….……………..………$5.99

Scotch Tape……………….……………………………….……………………..……….$4.49

Super Glue………………………….…………………………………………..…………$4.99

3 Quarters……………………………………………………………………..…………..$0.75

2 Spray Paint Cans...……………………………………………………………………...$7.92

Duct Tape…………………………………………………………………………………$2.94

Tax………………………………………………………..……………………………….$3.86

Total……………………………………………………….………………..…………….$51.67

**Results From Computer Simulation:**

**Reflections**

Our final assignment in ENGR 112 tested the cumulative knowledge the team had garnered throughout the course. We incorporated our skills in excel, VBA programming and graphing to properly simulate rocket projections. Essential theoretical concepts like thermodynamics, gas and pressure laws, laws of conservation, and Newtonian physics had to be integrated into the program to run successfully. The project was a huge undertaking to be completed in two weeks, as such, to prevent failure the three of us were required to properly manage our time and communicate together as a team. Lastly our writing and organizational talents were put the test as we developed a polished project report.

**Appendix A**

**Appendix B**