

## Bottle Rocket Lab

Name \_\_\_\_\_ Date \_\_\_\_\_ Group \_\_\_\_\_ Period \_\_\_\_\_

Most of you have blown up a balloon, and instead of tying the open end shut, you let it fly across the room. This is a simple, yet excellent example of Newton's third law of motion at work. You've also seen how different shaped objects can fall at different rates, if one has more air resistance than the other. You will use this information to formulate your hypothesis in this lab.

### Objective:

To have an empty, 2-liter soda pop bottle fly as high as possible using nothing more than water and air to make it work. The teacher will pressurize all bottles with the same amount of air using a tire pump. No part of the empty, 2-liter soda pop bottle can be removed to lessen its mass. You need to make your bottle aerodynamic and stable in flight while keeping any added mass to a minimum.

**Variables:** By the time you finish this experiment, you will need to identify the different types of variables present in this investigation. Consult your notes for definitions of the types of variables.

**Independent Variables:** \_\_\_\_\_

**Dependent Variables:** \_\_\_\_\_

**Controlled Variables:** \_\_\_\_\_

**Materials:** empty 2-liter soda pop bottle of equal size, tape or glue, file folder, stiff cardboard, scissors, ruler

### Procedures Day 1: Planning



An ordinary plastic bottle would be very unstable in flight so you need to add some fins to it. Your fins should be stiff enough to steer the rocket but not so heavy that it fails to go high enough. This is the reason for the stiff cardboard.

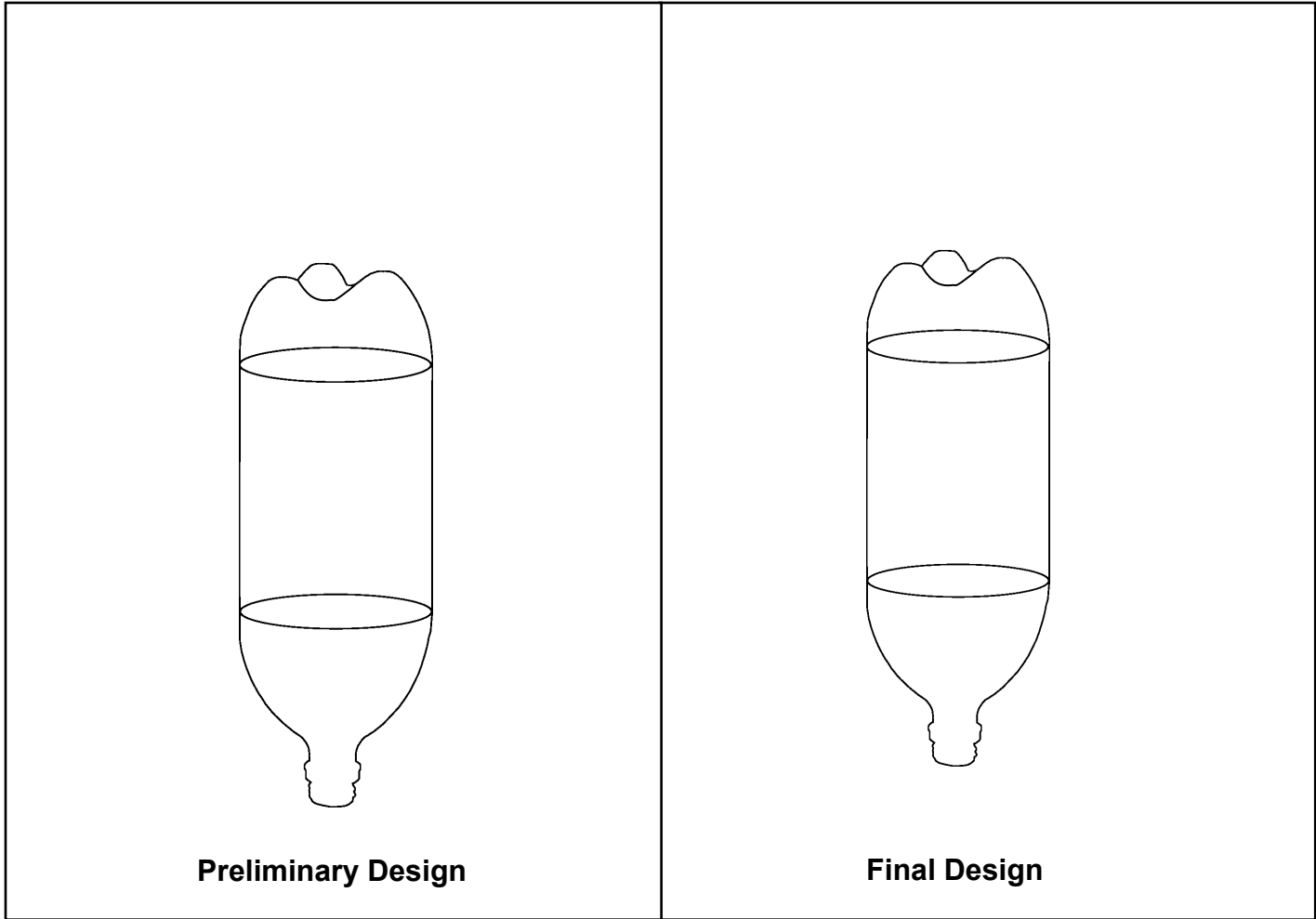


The fins must be securely attached with tape or glue so they don't rip away upon launch. Tape should be applied evenly and without wrinkling it. Fins must be symmetrically placed around the bottle. You'll need to measure the bottles circumference to do this.



To reduce air resistance a nose cone of some type must be secured onto the top of the rocket. The file folder will be used to make your nose cone. Your design must be symmetrical when viewed from the side and when looking downward at the rockets nose cone.

1. Make a preliminary sketch of what your plan will look like using pencil only. In your sketch, you will need to clearly label what everything is. Show this in the space labeled, "Preliminary Design"
2. Show your completed sketch to your teacher. If necessary, you may have to revise your plan if your teacher notices something that could disqualify your group's plan. Only after the teacher has initialed your plan, will you be allowed to proceed with getting the remaining materials.
3. If it's necessary to make minor changes in your design, show these in the space labeled, "Final Design"



## Procedures Day 2: Construction

### 1. Marking Fin location

- A. Your rocket needs to have either 3 or 4 fins placed along the bottom half of the bottle. They need to line up parallel to the long axis of the bottle and to each other.
- B. You'll need to determine the circumference of the bottle first. Once you know the circumference, divide that length by 3 if you'll use 3 fins and by 4 if you'll use 4 fins.
- C. Mark off this length around the bottle using a marker. Repeat for the other fins.
- D. Place your bottle against the frame of the door where it meets the door jamb. Draw a line down along the side of the bottle using the door jamb as a straight edge.
- E. Repeat for the other fin location marks.

### 2. Fin Construction

- A. The fins you make for your rocket should all be identical in size and shape. One side must be straight for attaching to the bottle and the edge along this straight side should be perpendicular to the piece of cardboard it is cut from.
- B. Once you have cut out one fin, use it as a pattern for drawing the remaining fins.
- C. When all fins are cut out, stack them on top of each other and check for any irregularities in them and trim them if needed.

### 3. Fin Placement

- A. Place a strip of masking tape along the root edge(the side facing the rocket) of each side of the fin and carefully align it on the fin lines previously marked on the rocket. Smooth out the tape and add extra tape as needed to keep the fin attached to the rocket.
- B. Repeat with the remaining fins. Check that the fins are lined up parallel to the length of the rocket.

### 4. Nose cone Construction

- A. Place a plastic, one gallon bucket onto an opened file folder and draw a circle on it using the bucket as a guide. Then cut out the circle.
- B. Fold this circle exactly in half . Mark the center of the fold line (diameter) using your ruler to measure it.
- C. Now cut the circle in half along the fold line( diameter ).
- D. Curl the two ends toward each other, forming a cone in the process with the mid point of the diameter as the tip of the nose cone.
- E. Place this folded cone over the top of the rocket (actually the base of the bottle) and adjust until it's the same diameter as the bottle. Tape the cone closed while holding it against the top of the rocket.
- F. Now tape the nose cone to the bottle once you have it centered on the bottle. Be sure to tape it all around to the bottle.

Label your rocket with your name and period. Once labeled, you can set it aside until launch day.

### Procedures Day 3 and 4: Liftoff

#### 1. Launch Preparation

- A. Your rocket needs to be filled with 100 ml of water. Use the cap you should have saved and screw it onto the bottle to keep it from losing any water on the way to the launch site.
- B. When it is time to launch your rocket, replace the cap with the threaded adaptor.
- C. Insert the adaptor into the launch pad receptacle.
- D. Put on safety glasses.
- E. Pressurize the rocket to 60 psi (pounds per square inch) pressure using the tire pump.
- F. Give a countdown from 5 and then squeeze the launch handle.

#### 2. Altitude Determination(if it's not too windy)

- A. Using a tape measure, position an observer 100 feet away.
- B. When the rocket launches, the observer will track its flight using a hand held altitude measurer.
- C. When the rocket reaches its peak altitude, the observer will "freeze" the pendulum of the altitude measurer. This will show the angle formed between the observer and the rocket. Record this angle here \_\_\_\_\_
- D. Using the table of tangents, write the tangent of that angle here \_\_\_\_\_
- E. Multiply the tangent \_\_\_\_\_ for the angle times 100 feet, and write the altitude in feet here \_\_\_\_\_

### Class Results

Group	Angle between observer and rocket at peak	Tangent of angle	Height reached	Group	Angle between observer and rocket at peak	Tangent of angle	Height reached
1				9			
2				10			
3				11			
4				12			
5				13			
6				14			
7				15			
8				16			

**Question 1-**Filling the bottle rocket with water first and then pressurizing it, makes it go higher than with just air. Use Newton's third law of motion to explain why having the water inside,which does makes it heavier,makes it go higher.

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**Question 2-** What was it about the highest bottle design , that made it better than the other bottles? Be specific and logical in your answer. You need to look at what other groups made.

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## Table of Tangents

Angle	Tangent	Angle	Tangent	Angle	Tangent
1.0	0.0175	31.0	0.6008	61.0	1.8037
2.0	0.0349	32.0	0.6248	62.0	1.8804
3.0	0.0524	33.0	0.6493	63.0	1.9622
4.0	0.0699	34.0	0.6744	64.0	2.0499
5.0	0.0875	35.0	0.7001	65.0	2.1440
6.0	0.1051	36.0	0.7265	66.0	2.2455
7.0	0.1228	37.0	0.7535	67.0	2.3553
8.0	0.1405	38.0	0.7812	68.0	2.4745
9.0	0.1584	39.0	0.8097	69.0	2.6044
10.0	0.1763	40.0	0.8390	70.0	2.7467
11.0	0.1944	41.0	0.8692	71.0	2.9033
12.0	0.2125	42.0	0.9003	72.0	3.0767
13.0	0.2309	43.0	0.9324	73.0	3.2698
14.0	0.2493	44.0	0.9656	74.0	3.4862
15.0	0.2679	45.0	1.0000	75.0	3.7306
16.0	0.2867	46.0	1.0354	76.0	4.0091
17.0	0.3057	47.0	1.0722	77.0	4.3295
18.0	0.3249	48.0	1.1105	78.0	4.7023
19.0	0.3443	49.0	1.1502	79.0	5.1418
20.0	0.3639	50.0	1.1916	80.0	5.6679
21.0	0.3838	51.0	1.2347	81.0	6.3095
22.0	0.4040	52.0	1.2798	82.0	7.1099
23.0	0.4244	53.0	1.3269	83.0	8.1372
24.0	0.4452	54.0	1.3762	84.0	9.5045
25.0	0.4663	55.0	1.4279	85.0	11.4157
26.0	0.4877	56.0	1.4823	86.0	14.2780
27.0	0.5095	57.0	1.5396	87.0	19.0404
28.0	0.5317	58.0	1.6001	88.0	28.5437
29.0	0.5543	59.0	1.6640	89.0	56.9168
30.0	0.5773	60.0	1.7317	90.0	-----