Bottle Rockets! (70 points)

Purpose:
To create a bottle rocket that will fly straight and will stay in the air for as long as possible.

Background Information:
Launching something as large as the space shuttle is a complex project. But scientists can send this huge vehicle into orbit partly because they understand the natural laws that describe how objects move. Scientists discovered these laws years ago. Yet the laws are still fundamental to every rocket launch, even the bottle rocket that you will launch in this lab. The same law that states how hitting a tennis ball makes it go faster also tells how rockets are launched.

a) **State Newton's three laws of motion (3 points)**
   1._____
   2._____
   3._____
b) **State Pascal's principle (1 pt)**
   _____

Group Hypothesis: **(5 points!)**
If we launch a bottle rocket, then the bottle rocket will fly… ***(State the direction of flight and describe the momentum as it lifts off and then falls to the ground)*** …because ***(apply at least TWO of Newton's three laws & the forces involved as the rocket falls to the ground)***

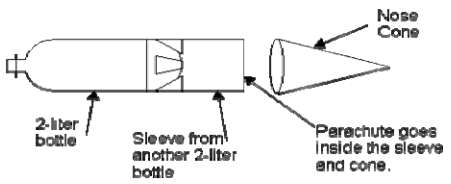
Materials:
1. One 2-liter plastic soda bottles
2. Duct Tape
3. Cardboard to make fins, Manilla folders, old Cds
4. A grocery bag to store your supplies, Stuff to decorate you rocket *(optional)*

Colored Drawing: (3 points)
Students will make a large **colored** illustration of their bottle rocket and **label** each part. You also need to label **where you will put the water** and which **portion is pressurized**.

Rules:
- Each group will use a standard 2-liter soda bottle to build their rocket.
- The 2-liter bottle must be used as the pressurized body. There may not be any cuts or holes in the 2-liter bottle, and no metal parts of any kind will be allowed on the pressurized body. Do not use hot water or sharp instruments on the pressurized body.
- When cleaning your bottle, do not use sharp instruments of any kind.
- **The mass of the empty rocket assembly may not exceed 300 grams.**
- All energy put into the rocket must originate from the water/air pressure combination.
- All rockets will be launched at a pressure not to exceed 60 pounds per square inch. Once the rocket is pressurized, no student can touch or approach the rocket!!!
- All students will be required to wear safety goggles at all times!!!
- Prior to launch, each rocket must pass a safety inspection and have the mass measurement taken.
- If the any part of the rocket becomes unattached during flight, the rocket will be marked as a detachment and no bonus points will be awarded.
- Students are not allowed to use hot glue or super glue in constructing their rockets. Cold glue is acceptable. Sanding is not allowed on the pressurized body.
- The use of duct tape is highly recommended.

Part I: Constructing Your Bottle Rocket

A) Below is a diagram of how your bottle rocket should be put together:



B) Nose Cone
   a. To construct the nose cone for you rocket use a piece of poster board or a manila folder.
   b. Draw a circle with a radius of six inches, and cut it out.
   c. Cut one slit from the outer edge of the circle to the center.
   d. Fold the poster board until it creates a cone that fits on top of you rocket,
   e. Attach the nose cone to the sleeve use a piece of string.

C) Fins
   a. Create 3 fins to put on the pressurized bottle.
   b. Fins can be created from poster board, manila folders, or cardboard.
   c. Fins need to be strong, and not flexible.
   d. Fasten the fins to your rocket using tape or glue. The fins need to be spaced equally apart.

Part II: Launching the Bottle Rocket

Safety: (5 points)

1. Students are required to wear safety goggles at all times.
2. Students are not allowed to approach or to touch the rocket once it is pressurized.
3. Students are expected to stay with the rest of the class and to be aware of rockets that are launched.
4. Students are expected to act mature and walk quietly to and from the field.
5. Create *your own* safety rule that you think is important for this lab.

Participation: (9 points)

- Each group member is required to contribute *equally*.
- 3 pt stamp for supplies on due date, 3 pt stamp for Day #1 contribution, 3 pt stamp for Day #2 contribution.
- Contribution means being involved in the design, the launch and discussing the analysis questions. It means that the student will not wander on the field or goof off.

Procedure:

Day #1

1) Assign roles to each team member: Timer, Recorder, Rocket PR (pump and run), and Altitude Tracker. Your partnering team will do the same. Record designated roles in appropriate places on template.
2) Build your rocket.
3) Mass your rocket ***(to the 100th place)*** and record on your Lab Template.
4) Measure the height in (m) ***(to the 10th place)*** of your Altitude tracker. Record in your data table. Also record your partnering teams' Altitude tracker's height and record.

Day #2

1) Get your rocket ready to launch.
2) Fill your rocket half full of water.
3) Put the cap on the end of the bottle and walk down to the field with your classmates.
4) Put your safety goggles on. Place your rocket on the launch pad.
5) **Rocket PR: Pump** the bike pump until you hit 80 PSI. Then, retrieve it and refill at water fountain.
6) Two of your double-group members will have a timer.
   a. **Timer 1& 2:** Start the stopwatch when the rocket is launched; stop timing when the rocket reaches its maximum height. Record the time in the appropriate column in your data table.
7) Two of your double-group members will be altitude trackers. Members will work in pairs with the recorders at a distance of 30 meters from the launch site.
   a. **Altitude Trackers 1 &2:** Will sight the rocket in the altitude tracker. The ***team recorders*** will read the angle shown by the string's location.
   b. **Recorders 1 & 2:** Record the degrees of altitude in the appropriate column in your data table.
8) Repeat steps #1-7 three more times (total 3 trials/launches). Calculate the averages.

Data Tables:

My Team's Recorder: _____ **Partnering Team's Recorder:** _____

My Team's Rocket PR: _____ **Partnering Team's Rocket PR:** _____

Data for MY TEAM'S ROCKET:

		Timer #1: _____	Timer # 2: _____
Launch #	**Pre-Flight Mass (g)**	**Total Time (s)**	**Total Time (s)**
1			
2			
3			
Average		**Average TIME for all 6 launches**	

Data for your PARTNERING TEAMS ROCKET:

		Timer #1:_____	Timer # 2:_____
Launch #	**Pre-Flight Mass (g)**	**Total Time (s)**	**Total Time (s)**
1			
2			
3			
Average		**Average TIME for all 6 launches**	

MY ROCKET'S Altitude

	Altitude Tracker #1 name: _____ **height in m** _____		**Altitude Tracker #2 name:** _____ **height in m** _____	
Launch #	**Altitude (°)**	**Altitude + Tracker's Height (m)**	**Altitude (°)**	**Altitude + Tracker's Height (m)**
1				
2				
3				
Average				

MY PARTNERING TEAM's Average Altitude: _____

<u>Analysis Questions</u>: (2 points each = 20 points total)

1) What is the average time for your rocket's flight and the average time for your partnering rocket's flight? What is the average altitude for your rocket's flight and the average altitude for your partnering teams?
2) How did your rocket design compare to your partnering team's rocket design? Do you think these design differences affected the time average altitude? Why?
3) Why did you only fill the pressurized body half way? Explain using Newton's 1st Law of motion (include the word **Mass** in your answer).
4) Did the rocket and the water move in the same direction? Explain using Newton's 3rd Law of Motion. *(explain what was the action and reaction)*
5) How does the momentum of the rocket change as it lifts off and hits its peak? How does it change as it falls back to the ground? In other words, what forces act **against** the rocket's momentum and **with its** momentum at different times during flight?
6) Would a rocket launched in the mountains have a greater momentum or a rocket launched at sea level? Why? **Include the word: Air pressure**
7) What causes the rocket to fly skyward?
8) How did Pascal's Principal apply to your rocket?
9) Why do you think that your rocket could not exceed 300 grams? *(Apply one of Newton's Laws)*
10) What factor's help keep the rocket stable? *(Hint: think about the design of the rocket)*

<u>Conclusion</u>: (9 pts)

Write a conclusion using your 7 sentence starters. Don't forget to elaborate and <u>underline</u> your starters!