Name: ____ Date: ____________________

Take Your Best Shot Worksheet

Introduction

In this activity, you will be measuring the distance water travels from a squirt (water) gun and comparing that to the number of times you pumped it. You will use this information to calculate the velocity at which the water left the gun. Then, starting with the exit velocity, you will use Bernoulli's equation to calculate the pressure inside the water gun chamber. Finally, you will compare the chamber pressure vs. the number of pumps by plotting the data.

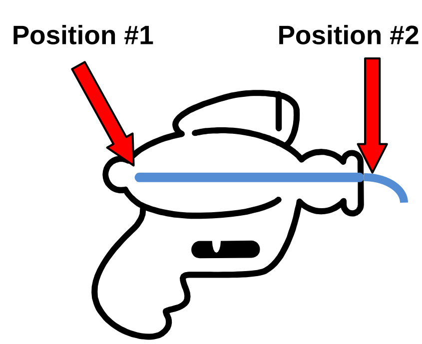
Background and Theory

To determine the pressure inside the water gun, you first need to know how fast the water is coming out of the nozzle. As the water droplets move from the end of the nozzle to the ground, they follow the rules of projectile motion. Using your understanding of these equations, you'll find the initial velocity of the water as it exits the nozzle.

Let's practice one together first. Assume that for your first data point, the height of the table was 0.800 m, and the water travelled 1.50 m from the edge of the table. Find the initial velocity of the water as it leaves the nozzle. Discuss strategies with your group, then show your work in the space below:

Now that you have velocity, you can solve for pressure using Bernoulli's equation. Because the Bernoulli equation equals the same constant at all points along a streamline, we can set the Bernoulli equation at two points equal to each other and use information on the system at one point to solve for information at another.

$$\frac{1}{2}\rho v_1^2 + \rho g h_1 + P_1 = \frac{1}{2}\rho v_2^2 + \rho g h_2 + P_2$$



For the example problem given above, find the water pressure inside the gun (P_1). [Hints: We know that the velocity of the water inside the gun (v_1) is initially zero, the pressure outside the gun (P_2) is the atmospheric pressure, or approximately 101,000 Pa, the density (ρ) is the density of water, and the relative heights (h_1 and h_2) are equal because we are keeping the gun level.] Show your work in the space below:

Setup-Aim…

1. Find a location where you have a long, flat space to shoot water. If the weather is nice enough, outside would be ideal.
2. Fill your water gun with water. Pump it a couple of times and shoot it, then top it off. So the water gun works properly, leave a small amount of air in the tank.
3. Mount your water gun on a sturdy surface approximately a meter above the ground. The gun should be mounted on its side and secured with duct tape. Once secured, make sure you can still squeeze the trigger and move the pump.
4. Measure the height of the nozzle above the ground.
5. Make sure to have a tape measure on hand to measure the distance later.
6. Designate one group member to be responsible for marking where the water lands.

FIRE!

1. Pump the water gun the number of times you have decided for your first trial, and shoot the water. Hold the trigger until the water has stopped coming out, to ensure that no pressure is left in the chamber.
2. Measure the distance between the nozzle and where the water lands.
3. Repeat this procedure for each trial.

Data Table
Draw your data table in the space below, and record your data and measurements in the table.

Number of Pumps	Maximum Distance (ft)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Calculations
Using the data you collected and the equations given in the Background and Theory section, solve for the pressure inside the water gun at each pump. To save time, try doing these calculations in an Excel spreadsheet. If you do the calculations by hand, show your work on a separate sheet of paper.

Graphing
On a separate sheet of graph paper, or in Excel, graph the pressure vs. the number of pumps. Also graph the distance the water travelled vs. the number of pumps. What does the graph tell you about the relationship between water pressure and the number of pumps?