CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
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Project Number
S0203

Project Title
Fire!: A Scientific Study of the Ratio between Barrel Length and Compression Chamber Volume

Abstract

Objectives/Goals
To determine the ratio of compression chamber volume to barrel volume [using length] at which the projectile achieves maximum distance from the initial volume of compressed air in the compression chamber.

Methods/Materials
PVC pipe, potatoes, sprinkler valve, pipe cutters, scale, 9 volt batteries, air compressor, blue pipe primer, pipe glue, Teflon tape, 1'-1' pipe connectors, ball valve, deburring tool, wrenches, square, tape measurer, tape, potato cutter, PVC end cap, 1" to 3/4" elbow, 1' threaded to straight adapters.
Using a corollary of the universal gas law [V(1)P(1)/T(1) = V(2)P(2)/T(2)] to find the approximate (no friction) length of the ideal barrel, we constructed our first potato cannon, making it exactly what we had calculated for the ideal length and cutting lower, reasoning that friction would cause the actual ideal length to be less then the approximated length. Then, cutting off approximately an inch at a time, we continued to shoot and measure the distance the projectile traveled.

Results
After the first battery of tests, our hypothetical barrel length proved to be correct for 7'5" with 80 PSI [pounds per in^2] behind it. After we cut the barrel down an inch the potato steadily decreased in distance.
The data show that as the barrel length increases, the distance of the shot increases until the barrel length reaches the point where the force of friction between the barrel and the projectile and the force exerted by the pressurized air are equal. After this point, increasing the barrel length decreased shot distance, until the shot did not have enough force to exit the barrel.

Conclusions/Discussion
The distance of the ideal barrel volume to compression chamber volume is fine-tuned by seal between the projectile and the barrel, whereas the PSI behind the projectile gives a kind of "ball park" figure, an approximation to be fine-tuned based on the coefficient of friction for the barrel and the projectile. The exact nature of this relationship is to be determined by further experimentation with a spring scale or similar instrument.

Summary Statement
This project focused on the optimization of a pneumatic cannon by varying the ratio between barrel and compression chamber volume using barrel length as the independent variable.

Help Received
Girlfriend major help with notebooks, Father taught us how to assemble PVC piping and helped with compression chamber design, Uncle gave basic pneumatic cannon design, parents bought some materials.