POP BOTTLE ROCKET PROJECT

TECH 382 POWER TECHNOLOGY
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INTRODUCTION

In this project a team of students designs, constructs, and tests a hydro-pneumatic propelled pop bottle rocket vehicle. The design component of this project incorporates the use of formulas that relate to the principles of rocketry. Construction of these rockets consist of readily available, low cost materials. Testing of the student

team design's includes static and dynamic examinations. Written and Oral reports will also be submitted to chronicle the design, construction, and evaluation of the student team's rocket submission.

The pop bottle rocket project is designed to be done in student teams as a competition. Student teams will consist of 4 to 5 members chosen at random by the instructor. The competition will be between the student teams (and perhaps the Professor). The competition will be based on two main categories: rocket design and performance. The design category is based on the use of high technology manufacturing methods and materials or creativity and appearance in the development of the rocket. The performance category is based on the results of static and dynamic examinations. These examinations may include: altitude attainment, acceleration, airborne or ground target accuracy, recovery devices, multiple stages, payload capacity, etc. The specific parameters of the competition will be determined in class by the students and Professor. The evaluation of the rocket project will be based on competition results, team and class peer performance reviews, written report, and oral class presentation.

The objectives of this project/activity include:

1. To foster teamwork
2. To evoke the spirit of competition
3. To develop problem solving skills
4. To use mathematics to develop the design
5. To apply theories and principles of rocketry to hands on application
6. To develop oral presentation and technical writing/reporting skills
7. To assist in preparation of Power, Energy, and Transportation Technology Educators
8. and to have fun

RULES

The rules of this competition are intentionally simple and few, intended to foster and promote creativity. New rules may be added if the need arises.

1. The rocket must be made using plastic pop bottles that fit our launcher
2. No metal components except for ballast washer(s)
3. Calculation and static testing of rocket design must be performed and approved by the instructor prior to launch.
4. Absolute maximum launch pressure 150psi

DESIGN INFORMATION

There are many factors that contribute to the development of a stable and reliable rocket. Some of these factors include the determination of center of mass or center of gravity (C.G.) and center of pressure or center of thrust and their relationship. Another factor includes fin size, shape, number, location and angle. Impulse thrust force and time and “fuel/propellant” mass and velocity are also important factors to be determined.

Center of mass or center of gravity (C.G.) is the point at which the rocket would remain in equilibrium or the balancing point of the rocket through an axis. The center on mass is determined by weighing the components and calculating or by balancing the completed rocket.

Center of thrust or center of pressure is the intermediate point of the surface area of the rocket. This point is determined by calculating the complete surface area of the rocket and determining the intermediate point.

The relationship of center of mass to the center of thrust is very important and is determined by their location and measuring the distance between the center of mass and center of thrust. In rocket theory the center of mass will try to lead the center of thrust. Maintaining approximately one rocket diameter between the center of mass and center of thrust is a good place to start in rocket design.

The quantity (mass) or proportion of water and the level pressurization is also very critical to the performance of the rocket.

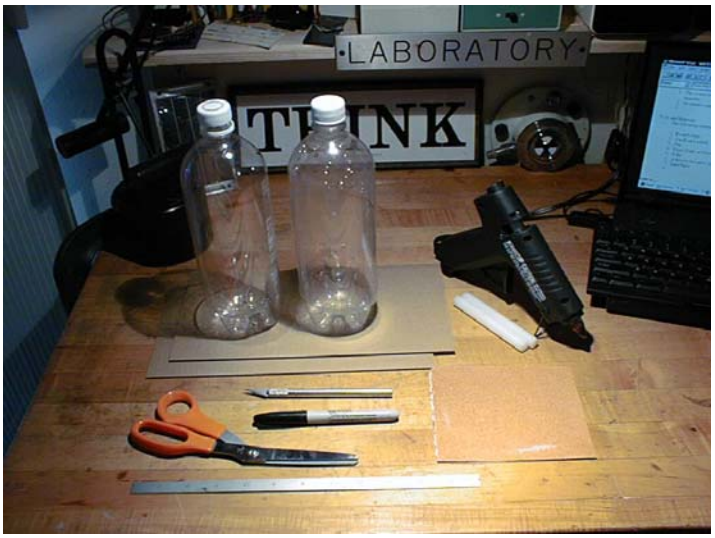
Relative calculations include: surface area of a cylinder, sphere, cone, and triangle

POP BOTTLE ROCKET CONSTRUCTION

The information presented here on the construction of a pop bottle rocket is to develop a simple rocket. Many other styles can be produced using different bottles, fin design, materials and production methods.

The following tools and materials are needed to successfully construct a pop bottle rocket.

1. Pop Bottles
2. Cardboard, plastic, or foam
3. Pen
4. Razor Knife or Scissors
5. Ruler
6. Adhesive (hot glue, silicone, goop, etc.)
7. Sand Paper
8. Ballast Washer
9. Safety Glasses



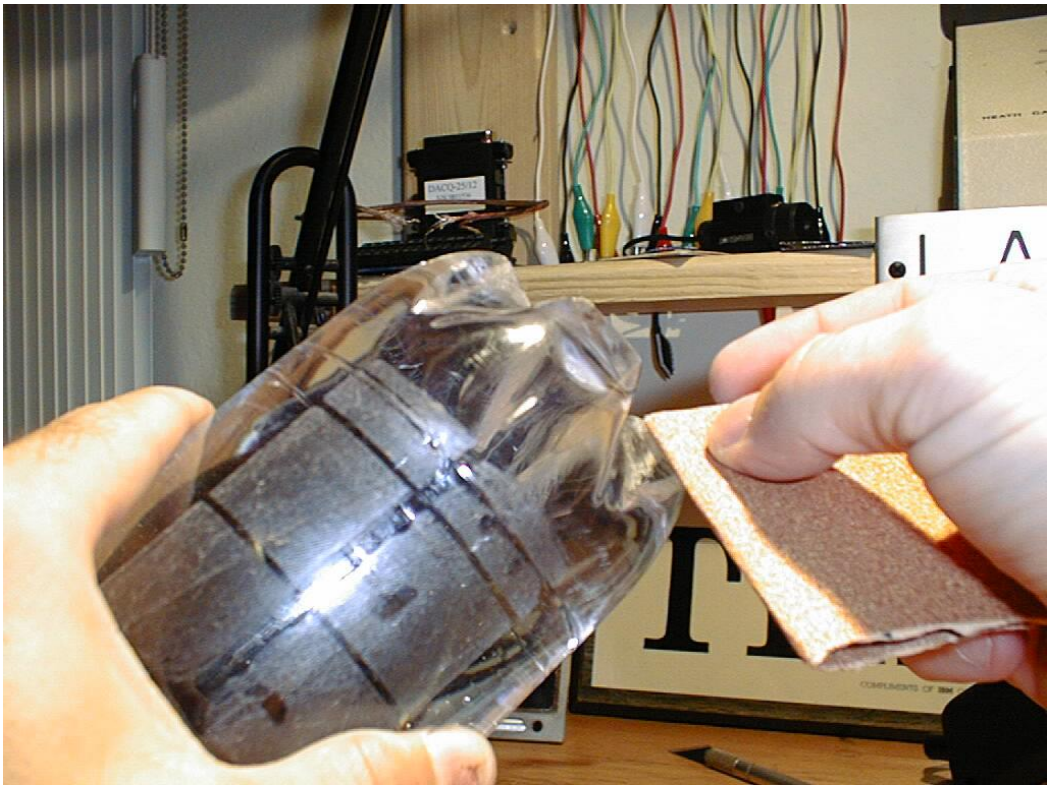
Materials needed for pop bottle rocket construction

Steps to follow to build a basic water bottle rocket.

Any size or shape of pop bottles can be used for this project as long as they fit our launcher. Prior to construction, you may want to pressure test your pop bottles to your expected maximum launch pressure to determine if the bottle deforms or ruptures *.

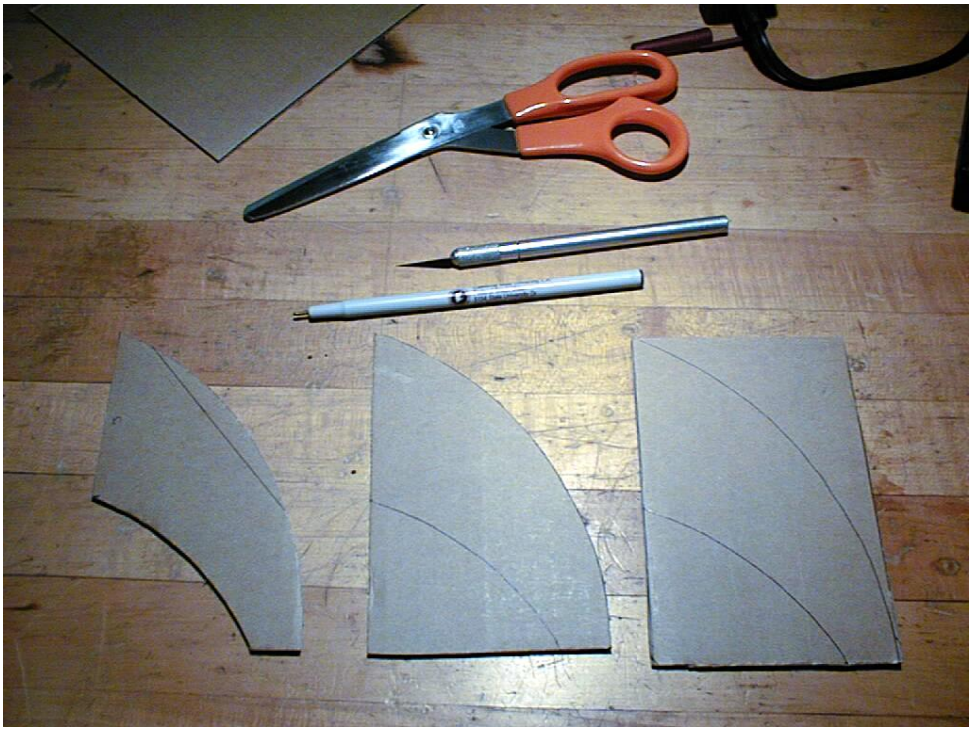
Note: Ask the Professor for more information on pressure testing to insure it is done correctly. Catastrophic failure of the pop bottles from over pressurization will result in an extremely loud bang and some flying debris. The noise and flying debris could injure bystanders or cause a response from the campus police. (Even though the entertainment value of a catastrophic failure (the bang, flying debris, and response of the campus police) is quite high, we want to refrain from these activities whenever possible.) Also, remember to use your safety glasses during testing and evaluation.

Use two plastic pop bottles who's bases fit well together.

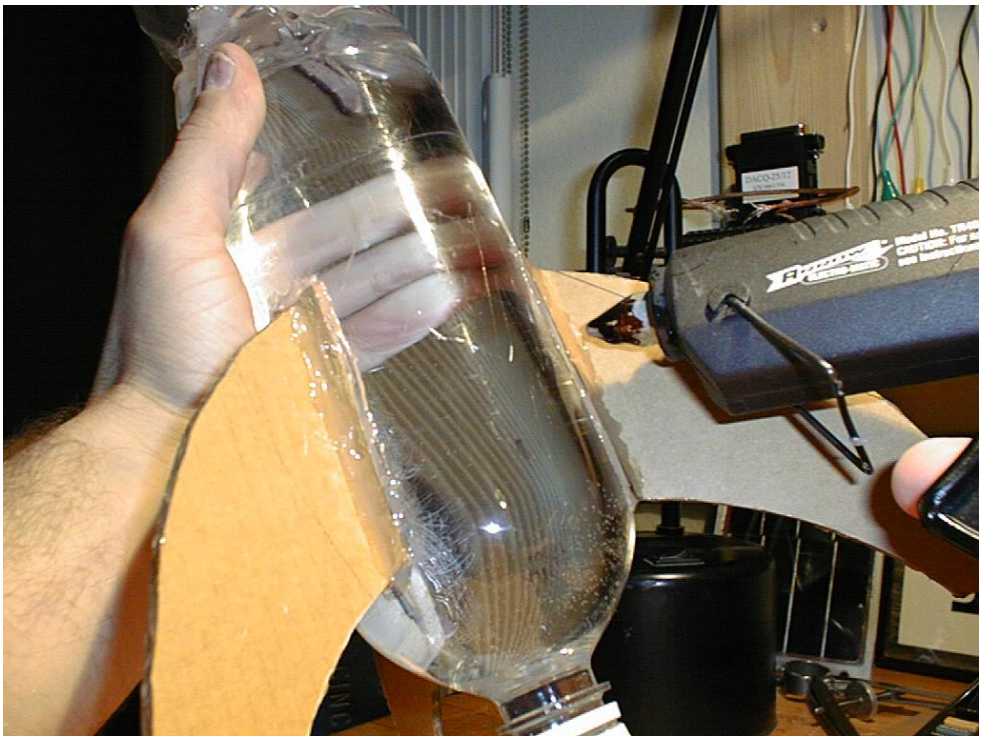


Fill both bottles with water and lightly sand the base areas where glue will be applied

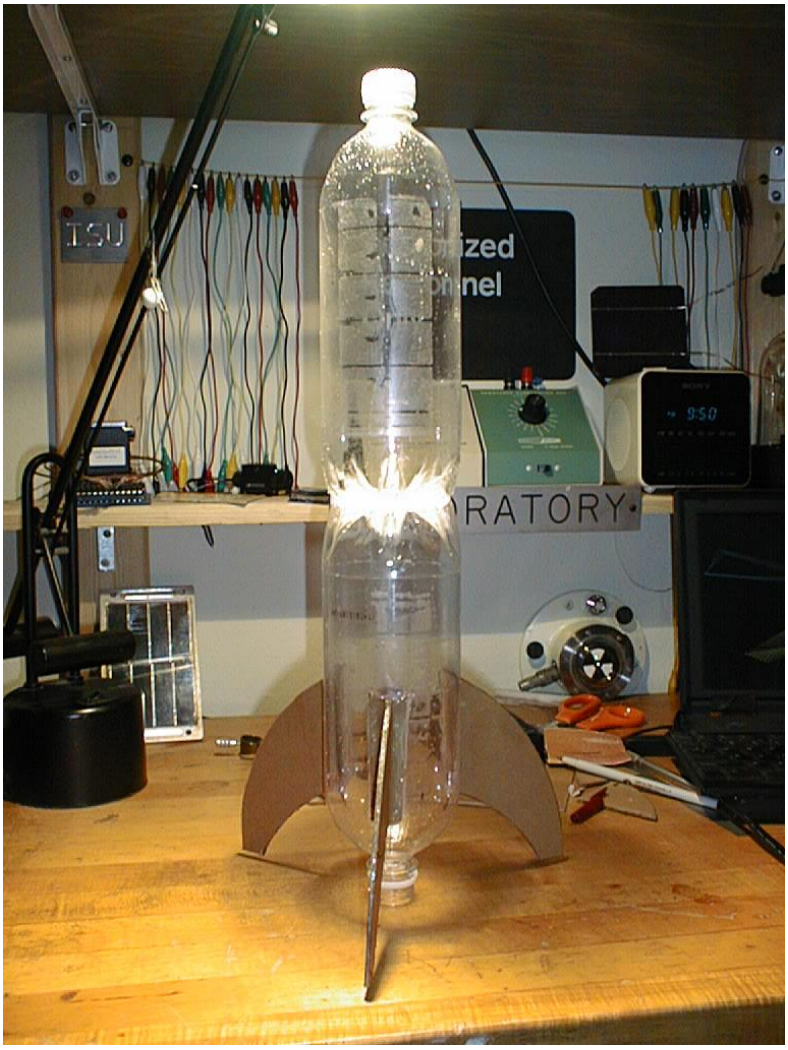
Glue the two bases of the pop bottle together. May different type of adhesives have been used in the past with great levels of success. A flexible hot glue is preferred by the Professor because it hardens quickly which allows rapid construction.



Design fins for your rocket and cut them from the cardboard. The size, shape, and number of fins effects the stability of the rocket in flight. Be sure to determine the total area of the fins. To determine placement of the fins on the rocket, measure the diameter and calculate the circumference (or measure). For equally spaced placement of the fins divide the circumference by the number of fins and measure the distance, and mark the placement of the fins on the bottle.



Lightly sand the sides of the bottle where the fins will be placed and glue the fins to the bottle. Placing a slight angle on the fins will cause the rocket to spin in flight increasing its stability but also increasing its drag.



The completed rocket is shown.

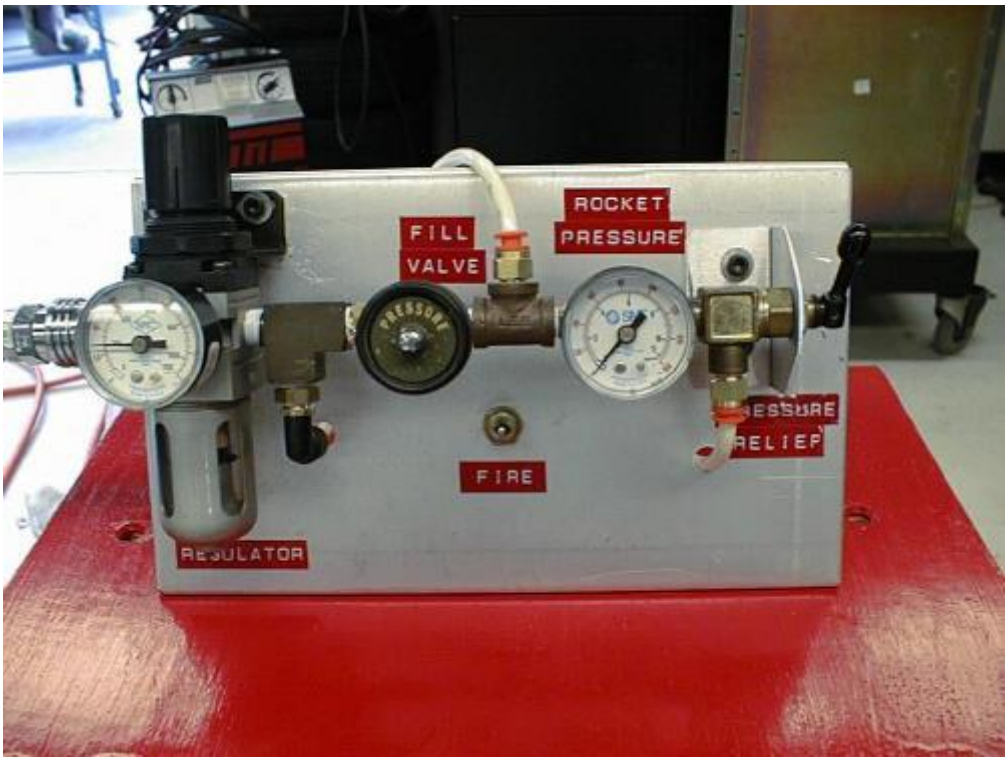
A metal ballast washer that fits under the bottle cap nose cone may be needed to improve the center of mass to center of thrust relationship.
To improve the overall appearance and potential performance of the rocket a few things can be done. Use a rolled manila folder to make a more attractive nose cone. Also a rolled manila folder makes a good collar to cover the glued bases. Spray paint will greatly improve the appearance of the rocket besides helping to protect the cardboard fins from water damage.

The same rocket after some cosmetic and potential performance improvements

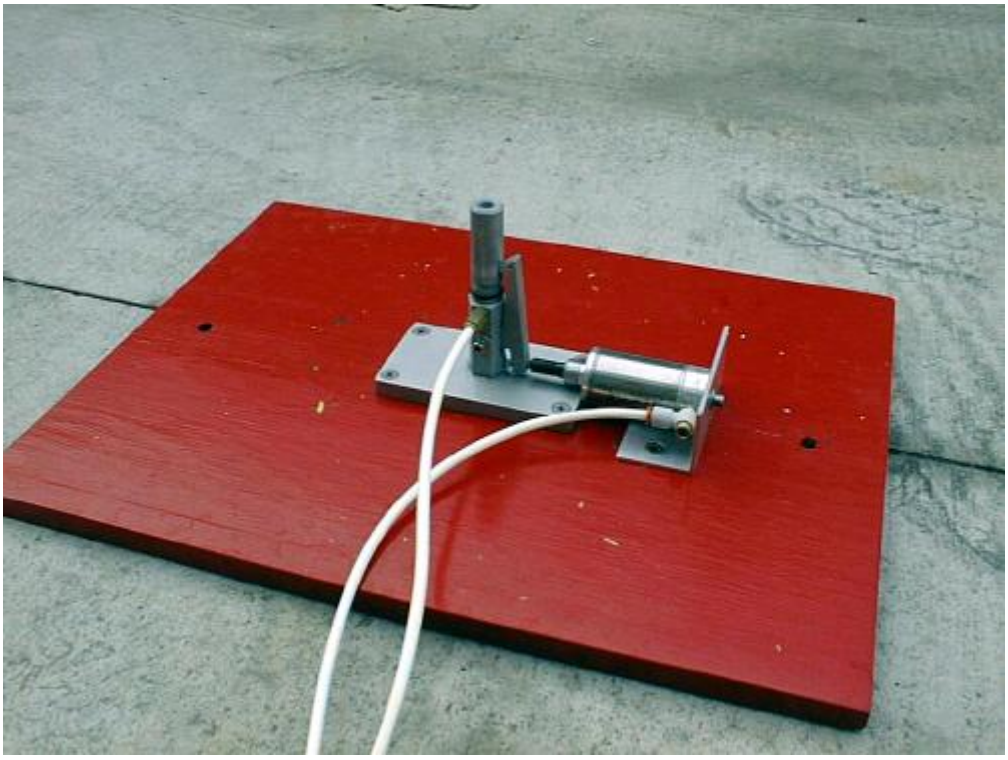
TESTING AND EVALUATION

After the rocket design, calculations, and construction has been approved by the Professor testing and evaluation can be performed.

Static tests include balance, swing, and spin testing. Dynamic evaluation includes: filling the rocket with a predetermined amount of water, placing the rocket on the launcher, pressurizing the rocket with air to a predetermined level, and launching the rocket. The rocket should fire straight off the launcher and attain a stable flight.



Launch Controller


Launcher

Past POP BOTTLE ROCKET PROJECT Teams

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Rocket Teams Fall 2000


WILDFIRE
91

Rocket Teams Winter 1999


TRUCK
CAR
POLO


TRUCK


TRUCK