

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
Department of Aeronautics and Astronautics  
16.010 / 16.020 Unified Engineering  
**Systems Problems #6**

Issued: October 15, 2003

Due: 5PM October 23, 2003

**WATER ROCKET IMPLEMENTATION AND OPERATION**

**Objectives**

1. Implement and Operate (IO) the water rocket that you have conceived and designed (CD)
2. Measure the performance of a system.
3. Compare and analyze observed performance with predicted performance based on modeling and engineering analysis.

**Mission Statement (Recap from SP5)**

Your goal is to design a water rocket to whose primary function is to achieve maximum altitude. However, your design must conform to the following *constraints*:

1. The water rocket must begin from rest at ground level.
2. You must utilize the given launching mechanism without modification or alteration.
3. The sole source of stored energy must be compressed air at a maximum of 60 psi gauge pressure.
4. You must launch your rocket three times in rapid succession (<5 minutes turn around time). The average altitude of the three launches is your performance rating.
5. You may use any components or construction materials you wish as long as your design is safe to operate.

**Particulars (Recap from SP5)**

1. Certain construction materials will be freely available from the TAs while in stock including balsa, clay, hot glue, and Household Goop™.
2. Launching mechanisms and inclinometers for measuring altitude will be available for sign out from the TAs during business hours. The maximum sign out period is two (2) hours except when sign out occurs after 4pm in which case return must occur at 9am the following business day.
3. Another person must be present during launch for safety and to help you launch or measure altitude.

## Safety

Your bottle rocket, when pressurized to 60 psig, can be a very dangerous object, capable of causing severe injury. Several safety precautions must be taken before and during your launches:

You will need to get from the TAs: a launcher, a launch retainer pin, an inclinometer, and a few metal stakes (1-3). You'll want to bring an ample supply of water to the launch site with you as well. The TAs may also have a measuring tape available so that the altitude-recording person can determine his or her distance from the launcher.

1. Go to an open area, clear of people, cars, etc. (Briggs Field is a good launch site)
2. After filling the bottle with water and attaching it to the launcher, stake the launcher to the ground.
3. Make sure that the bottle is completely seated on the o-ring at the base of the launch rod.
4. Insert the launch retainer pin, making sure it will restrain the bottle by passing over the bottle's neck ring.
5. Carefully pressurize the bottle. At no time should you stand above the bottle. Assume it could blast off at any moment. Do not pressurize the bottle beyond 60 psig.
6. When fully pressurized, make sure that nothing is in the way of the rocket, stay clear, and pull out the launch retainer pin.
7. You will need a partner to record the altitude of the rocket using an inclinometer. Be sure to measure or estimate the distance that your partner is standing from the launch pad so that you can compute the rocket's altitude given its angle above the horizon.

## Assignment

1. Build and launch the water rocket that you designed in SP5. If you wish, record preliminary test flight data as you get any small bugs worked out.
2. Launch your water rocket in a final set of three launches (we'll call this your rocket's competitive data, though you aren't really competing against one another). Record your rocket's competitive performance data for each launch, and the average altitude attained.
3. Create a short written **Performance Report** using the following outline:
  - I. Launch Data and Analysis**

You may wish to present your test flight data. You must present your competitive flight data.
  - II. Design Performance**

Evaluate the performance of your rocket against your original functional requirements. Compare observed vs predicted altitude performance. Present

plausible arguments to explain discrepancies between observed and predicted altitude performance.

### **III. Conclusion**

Present any concluding remarks regarding the water rocket conception, design, implementation and operation process. (What did you learn? Did you have fun?)

Original: DFrey Fall 1999

Modified: JKKuchar /CPColeman Fall 2000

Modified: CPColeman Fall 2001

Modified: CPColeman Fall 2003