AAE 190
Assignment 5: Water Rocket

Introduction

This project is designed for you to take a look at energy conversion in a rocket and how it is converted to altitude. **<u>We will meet in the Memorial Mall near John Purdue's grave on Thursday, October 19, at 9:30AM (normal class time)</u>**. If the weather is bad we will meet at the Armory Drill Floor. You will launch water rockets and collect data to determine the performance of a rocket with payload.

Objectives

1. Acquire data on the range (height) of rocket for different loads of water (between 0 and 591mL(20 oz.)).
    a. We will be using a constant pressure, 60 psi.
    b. Plot height vs. mass of water loaded into rocket.
2. Predict
    a. For a payload of 20g, mathematically determine the mass of water that would be needed to deliver the rocket to Low Earth Orbit (LEO). The altitude for desired LEO will be 50 ft.
    b. Determine the maximum payload that could be delivered to LEO.

A report on the above tasks will be due on Thursday, October 26.

Procedure

1. Determine different amounts of water needed to obtain a good plot of height vs. water mass.
2. Bring paper and pencil to record data.
3. Watch the TAs closely as they describe the procedure at the beginning of class.
4. You may want to talk to other groups and share data with them, as time will be short and you may not have time to get all of the launches you plan to get.

Report

1. The report must include, but is not limited to:
    a. Introduction
    b. Procedures
    c. Results
        i. A plot of height vs. water mass
        ii. Amount of water needed to deliver specified payload to LEO.
        iii. Maximum payload that can be delivered to LEO.
    d. Other observations (e.g. effects of wind, stability,…)
    e. Conclusions
2. Your report is due on October 26, 2000.

NOTES:

Thrust

- Energy is stored in the bottle by pump compressing the air.
- At the release of the rocket, energy is transformed into
  - kinetic energy of the water rushing out of the rocket
  - kinetic energy of the rocket going up
  - potential energy of rocket and water within the rocket
  - energy losses
    - viscous drag of water through nozzle
    - viscous drag of air over rocket
    - little bit of heat transfer

How much energy can be extracted?

- Energy stored in the compressed air
  - Depends on the difference between pressure put in and atmospheric pressure

$$E = (P-P_o)V$$

P = air pressure [N/m^2]
P_o = atmospheric pressure [N/m^2]
V = volume of air at launch [m^3]

- Energy potential at top of the flight

$$E_p = mgh$$

m = weight of rocket and payload [kg]
h = height above the ground [m]
g = gravitational constant [9.8 m/s^2]

- Energy lost
  - Difference between the above two energies
    (had E to turn into E_p, but only so much of it actually got converted)

$$E_L = E - E_p$$

can be expressed as an efficiency

$$\eta = E_p/E$$

- Analysis Option
  - Break it up into boost and coast phases since rocket is not lifting the water during coast phase.