FSEA PROJECT PLANS

September 15, 1999

THE ADVANCED ROCKET RK2

Applicable Grades	6th through 12th
Number of Members Per Team	Two
Number of Kits Per Team	Not Applicable
Number of Sessions	Six to Seven

SKILLS AND ENGINEERING CONCEPTS DEVELOPED:
Introduction to basic aerodynamics, rocket propulsion and Newton's Third Law of Motion. Development and implementation of concepts to prolong flight.

NOTE: This project requires launching of the rockets outdoors. Consideration must be given to possible weather conditions when scheduling this project.

INTRODUCTION

A rocket is defined as a device propelled by the expulsion of gasses, usually generated within the device itself. The rocket's motion results from the reaction to its exhaust blast (much like the recoil of a gun), and is explained by Newton's Third Law of Motion, "For every action there is an equal but opposite reaction."

The principle of a rocket motor may be understood by considering a closed container filled with a compressed gas. Within this container the gas exerts equal pressure on every point of its walls. If a hole were punched in the bottom of the container, the gas at the bottom would escape, and the pressure against the top of the container would no longer be equalized. Hence the internal gas pressure would tend to move the container as a reaction to the jet of air escaping downward.

For this project, propulsion of the rockets will be accomplished by a pressurized air/water mixture. Information regarding compressed air rockets is available on the world wide web, a place to start is www.H2O.Rocket.com.

OBJECTIVE

The objective of this project is to introduce the students to some basic rocket physics. This will be accomplished by having the student teams design and construct rockets that can carry a payload (an egg) aloft and return it to earth unbroken. A competition will be held to determine which team's rocket design can achieve the maximum time aloft for their payload.

PROJECT DESCRIPTION

Student teams will design and construct their rocket's payload sections in accordance with the design constraints identified. The teams may decide to try various rocket payload configurations to determine which design works best.

THE ROCKETS WILL BE POWERED BY COMPRESSED AIR/WATER ONLY. NO FLAMMABLE OR EXPLOSIVE FUELS MAY BE USED.

After teams have constructed their rockets, the mentors will set up the launching mechanisms and assist in conducting test launches for the teams (see Appendix I for details on launching rockets using the launcher provided by FSEA). Teams may also vary the amount of water and pressure (pressure may not exceed 80 PSI) in their rocket to determine which combination maximizes flight time.

Teams are responsible for obtaining their own bottle for the rocket body and constructing any and all rocket attachments. FSEA will supply material for the construction as identified in the Facilities and Equipment (material) Required section.

After teams have constructed their rockets, the mentors will set up the launching mechanisms and conduct test launches for the teams. See Appendix 1 for details on launching rockets using the launcher provided by FSEA. Teams may try various configurations to determine which design works best.

At the completion of the testing phase (usually 2 to 3 weeks), a competition will be held to determine which teams' payload stays aloft for the longest period of time (and is recovered intact). Note that each team of two students will build two rockets, but each team may only enter one rocket in the competition.

DESIGN CONSTRAINTS

The volume of the bottle must not exceed two liters or be less than one liter.

The neck of the bottle must be compatible to the launch mechanism, which is designed to use a two liter bottle. Note that various bottle companies make various size rings on the neck of their plastic bottles. Some neck rings are too small, causing premature launch. Teams may want to try their bottle in the launcher before spending considerable time in the construction of a rocket. The payload (egg) may be attached to the body of the rocket, or it may separate from the rocket after launch. Either design is acceptable.

NO METAL OR GLASS PARTS MAY BE USED ANYWHERE IN THE ROCKETS DESIGN (INCLUDING ADDED ITEMS SUCH AS PARACHUTES, ETC.).

COMPETITION

The competition will be to launch an egg and recover it intact. The scoring will be the time the egg is aloft. If the egg breaks, the score is zero. Each team will get two rocket launches (using either the same rocket for both launches, or a different rocket for each launch).
Each flight will be timed from moment of launch until touchdown of the payload. The times will be recorded.

The following rules will govern the competition:

1. All rockets must meet the specific requirements defined in the Design Constraints section.
2. Launch pressure cannot exceed 80 psi.
3. A malfunction of the rocket or launching mechanism prior to launch (loss of water, pressure, etc.) will not count against the team as a launch.
4. If pieces of the rocket separate during launch and/or flight, the time to touchdown will be recorded when the payload of the rocket lands.

If for some reason it is impractical to conduct the competition utilizing real eggs, the #2 fishing weights may be placed inside the plastic eggs. The plastic eggs may then be used as cargo. Obviously, use of the plastic eggs makes a determination of whether or not a real egg would have broken impossible, so that criteria is no longer a part of the judging or scoring.

CONSTRUCTION

A basic rocket is constructed by attaching fins around the circumference of the plastic bottle. The fins may be attached by a hot glue gun or a strong light weight cellophane or plastic tape.
NOTE: Fill the bottle with water first and attach cap. This prevents distortion of the plastic bottle while putting on attachments. The fins may be of cardboard, foam board or any other non-metallic, non-glass material as appropriate (light weight yet non-flexible).

To the basic rocket, students may elect to add streamlining, a nose cone, a parachute, wings, or any other attachment they choose. The only restrictions should be in the materials they select (see Design Constraints). As always, the appropriateness is left to the students, at the discretion of the mentors. The payload may be integrated to the body of the rocket, or it may be detachable. This is left to the teams to decide upon and design. The plastic egg can be used to design the cargo hold to the correct size prior to the purchase of eggs for the competition. The real eggs used for the competition should be wrapped in the sandwich bags, and then placed in the cargo bay.

LESSON PLAN BY SESSION

This is a guide only.

Session #1 - Discuss rocket project.
Newton’s Third Law of Motion
Demonstration/Discussion of letting go of blown up balloon/random flight
Directed flight - fins (drag) for direction and stability (orientation)
Have examples of one and two liter bottles

Discuss the launching of the rockets
Discuss parachutes--fixing them to rocket and ensuring they open, etc.
Discuss integral vs separate payload design concepts
Form teams
Assignment--each student bring in a 2ltr plastic bottle next session.

Session #2
- Construct rockets
- Glue or tape on fins
- Attach parachutes (if applicable)

Sessions #3 and #4
- Test launch rockets
- Repair and/or modify rockets as necessary
- Continue test launchings

Session #5
- Competition.

Session #6
- Conclude competition. Conduct post-competition discussion, where students discuss what did and what did not work, and why.

FACILITIES AND EQUIPMENT REQUIRED

Provided by Students
- Plastic bottles (with cap preferred), one per student.

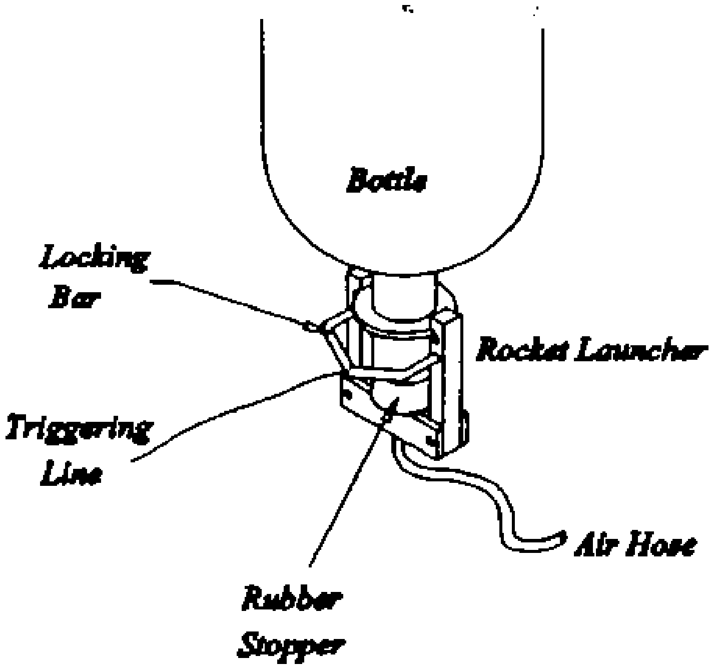
Provided by FSEA
- Stop Watch
- Tape
- Launching mechanism
- Air pump
- Fins (at least 3 per student)
- Plastic parachute material (1 plastic bag per student)
- String for parachute risers (6' per student)
- Plastic egg (one per student)
- #2 fishing weight
- Sandwich bags for wrapping eggs

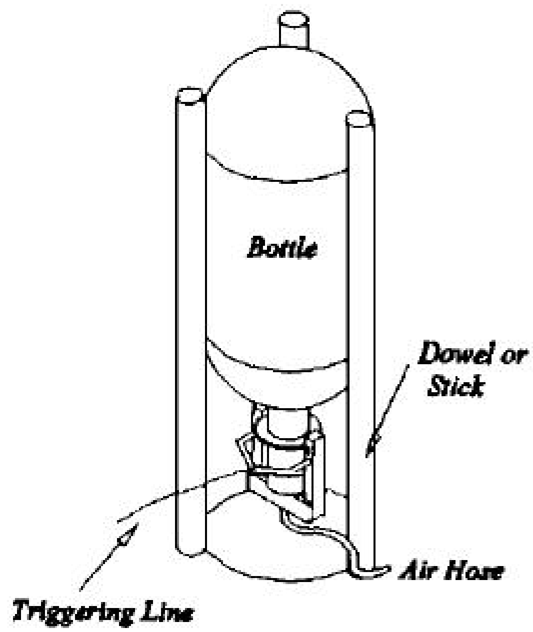
Optional Material - Provided by mentor/students if desired
- Glue gun and glue
- Additional material for parachutes, wings, nose cones, etc.
  - Plastic, string, cloth/material, cardboard tubes, cardboard etc.

APPENDIX 1: LAUNCHING THE ROCKET

To set the ready the launcher, push the two long legs firmly into the ground. You may want to push the legs through a piece of plastic to keep the ground from getting saturated during multiple launches. Be sure to set the rocket launcher well away from trees, telephone wires and buildings.

To attach the bottle to the launcher press the rubber stopper firmly into the neck of the bottle. Notice that each short arm of the launcher has a slot cut into its side. Swing these arms up so that each slot fits over the neck ring of the bottle. When the neck ring is firmly held in the slot of each arm, insert the u-shaped locking bar. See the assembly diagram for details. If necessary, you can stabilize the rocket upright by using dowels or sticks placed in the ground surrounding the rocket.





CAUTION

DO NOT LOOK DOWN AT THE ROCKET DURING PRESSURIZATION
DO NOT AIM THE ROCKET AT ANY PEOPLE OR STRUCTURES
WEAR PROTECTIVE EYE GEAR WHILE LAUNCHING

The stability of the rocket depends on many factors, length, fins, nose cone, all of these can affect the rocket. Cardboard tubes can be used to lengthen rocket bodies. Fins greatly improve the stability of the rocket. FSEA will provide fins, but should you have additional material and wish to experiment with the students, do so. Fins do not have to be large to be effective. They can be made from scrap cardboard, cardboard boxes or other material. Fins can be glued or taped to the rocket bodies. Fins tend to work best when placed near the base of the rocket, but you can also experiment with this.

The nose of the rocket is another point of consideration. The nose of the rocket does two or three things: first, it streamlines the rocket so that air passes over with efficiency; second, it must hold the parachute or other recovery system; third, it is usually the part of the rocket which must protect the payload. It is important to note that the nose of the rocket usually absorbs a considerable impact should the parachute fail to deploy, and this should be considered in the amount of time spent on this design feature (and the cost or availability of the material employed).

The parachute can be made by cutting a circular patch from a large plastic garbage bag. Lengths of string about 60 centimeters long (2 feet), can be cut and taped around the perimeter of the parachute. Gather the free ends and tie them in a knot and attach to the bottle. Gently roll up the parachute and place on the top of the rocket or in a nose cone device (this is a critical step, as deployment of the parachute is essential for prolonged flight and the safe recovery of the payload.

SAFETY PROCEDURES

DO NOT LOOK DOWN AT THE ROCKET DURING PRESSURIZATION

DO NOT AIM THE ROCKET AT ANY PEOPLE OR STRUCTURES

WEAR PROTECTIVE EYE GEAR WHILE LAUNCHING

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