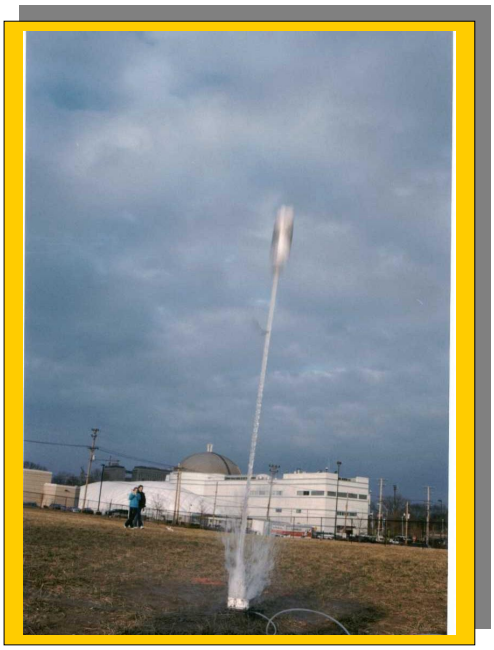
Dynamic Design: Launch and Propulsion

Fly Me High

TEACHER GUIDE

BACKGROUND INFORMATION



Students will work in their design groups first by spending time sharing what was learned in each of the expert groups. Design groups will begin with the students using what they learned to design a water rocket that will be tested. Once the teacher has approved the designs, students may assemble the materials and begin building each rocket.

Students will contribute the background information they learned in their expert groups to the design group. Because the actual rocket designers do not use the first design they create, your students will also be able to test two preliminary designs before deciding on the final one for the contest. Feel free to allow the experts to return to their expert groups for consultation when/if necessary.

Once students have completed construction and before the first test launch, the rockets should be put through a stability test. In this test adopted from NASA's *Rockets: A Teachers Guide with Activities in Science, Mathematics, and Technology,* design groups will determine the center of mass and the center of pressure for their test rockets. The center of mass is the point about which the rocket balances. Students could practice this by trying to balance a ruler on one finger. The center of pressure is the point where half of the surface area of a rocket is on one side and half is on the other. Students could model this by finding the mid-point of a ruler. A stable rocket has the center of mass in front of the center of pressure. Once the design group has found these centers on their rocket, they should complete the swing test to verify rocket stability. The swing test has student groups attaching a string loop to the rocket at the center of pressure and another string to this loop. While swinging the rocket in a circle, the rocket should point in the direction is it being swung if it is stable.

NATIONAL SCIENCE STANDARDS ADDRESSED

Grades 5-8

Science As Inquiry

Abilities Necessary to do scientific inquiry

Physical Science

Motion and Forces

Science and Technology

Abilities of technological design

Understandings about science and technology

Science in Personal and Social Perspectives

Personal health

Grades 9-12

Science As Inquiry

Abilities Necessary to do scientific inquiry

Physical Science
Motion and Forces
Science and Technology
Abilities of technological design
Understandings about science and technology
Science in Personal and Social Perspectives
Personal and community health

(View a full text of the National Science Education Standards.)

PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS ADDRESSED

Measurement Standard for Grades 6-8
Understand measurable attributes of objects and the units, systems, and processes of measurement
Understand both metric and customary systems of measurement
Apply appropriate techniques, tools, and formulas to determine measurements
Select and apply techniques and tools to accurately find length and angle measures to appropriate levels of precision

Problem Solving Standard for Grades 6-8
Solve problems that arise in mathematics and in other contexts

Measurement Standard for Grades 9-12
Understand measurable attributes of objects and the units, systems, and processes of measurement
Make decisions about units and scales that are appropriate for problem situations involving measurement

Problem Solving for Grades 9-12
Solve problems that arise in mathematics and in other contexts

(View a full text of the Principles and Standards for School Mathematics.)

NATIONAL EDUCATIONAL TECHNOLOGY STANDARDS ADDRESSED

Technology Standards for Students K-12
Technology productivity tools
Students use technology tools to enhance learning, increase productivity and promote creativity.

Technology research tools
Students use technology to locate, evaluate, and collect information from a variety of sources.

Technology problem-solving and decision-making tools
Students use technology resources for solving problems and making informed decisions.

Technology Standards for Students 6-8
Use content specific tools, software and simulations to support learning and research

Collaborate with peers, experts, and others using telecommunications and collaborative tools to investigate curriculum-related problems, issues, and information, and to develop solutions or products or audiences inside and outside the classroom

(View a full text of the National Educational Technology Standards.)

MATERIALS

- One or more 2-liter plastic soft drink bottles
- Safety goggles
- Glue or tape
- Card board or thick paper
- Modeling clay
- Scissors
- Pens and decorating supplies
- Balance
- Launch pad with secure pin and washers
- Water
- Safety goggles
- Air pump or tank
- Altitude tracker
- Decorative decals
- *Rockets: A Teacher's Guide with Activities in Science, Mathematics, and Technology* (Information about stability, pages 116-117; 109-110 NASA file.)
- Appendix A, "Safety Rules"
- Appendix B, "Safety Checklist"
- Student Activity, "Fly Me High"

PROCEDURE

Alternate Strategy Tip

During this sharing time in the design groups, allow students to use the free-ware called Water Rocket Fun by Tony Wayne. Visit http://www.Seeds2Learn.com for this free water rocket software.

1. In their design groups, each student should share what was learned in the expert group. Recommendations for the design phase will be shared. During this time teachers should encourage group members to ask questions of the experts. Assign students in each group the following jobs and review the role of each.
   - Safety Officer: Checks for safe practices and can stop a launch whenever unsafe practices are observed.
   - Loading Officer: Responsible for securing the rocket to the pad and charging the rocket with the appropriate air pressure.
   - Principal Investigator/Launch Officer: Commences the countdown and launches the vehicle.
   - Downrange Officer: Observes the launch, measures the height of the rocket at **apogee**, and records data. Spots the rocket and assures the safe landing of the rocket.

2. Distribute a copy of Appendix B, "Safety Checklist," for each design team. Go over the list and answer any questions students may have. Review the following competition rules:
   - Only materials approved by the teacher may be used in construction of any part of the bottle rocket system.
   - Safety rules and checklists must be followed at all times.
   - The rocket may not be pressurized over 75 PSI

3. After each person shares information from the expert groups, the design group should decide what variables should be tested during the design phase. During this time experts in the design group should have input into the design process for the component they worked during the expert work. Final decisions for the designs of the rocket will be up to the principal investigator in each design group. The teacher should review and approve rocket designs before construction begins.

4. Allow students time to assemble the materials before construction. Students should then measure the mass of the cone, body, and tail. With this information along with the volume of water they plan to use and the air pressure, students can go to this Web site http://www.ag.ohio-state.edu/~rockets/cgi-bin/design_zone.cgi input their numbers and receive some data. This feedback may allow them to redesign their rocket before construction. Students will then construct the rocket in each group. A deadline should be given such that launches occur on the same day.

5. Once construction is complete, students should complete a rocket stability determination. The directions included here were adopted from NASA's *Rockets: A Teacher's Guide with Activities in Science, Math and Technology* (p. 116-117). Distribute this sheet to the design groups as they finish construction. In this activity, students will determine the center of mass and the center of pressure. Ask students to name a challenge with testing the center of mass. (Some students may point out that as the fuel is used the center of mass changes.) Students can then make adjustments to their rocket prior to launch.

6. If it you desire to have one overall winner, the launch that results in the hightest altitude is the winner.

7. During the launch students should assume the following roles:
   - Safety Officer: Checks for safe practices and can stop a launch whenever unsafe practices are observed.
   - Loading Officer: Responsible for securing the rocket to the pad and charging the rocket with the appropriate air pressure.
   - Principal Investigator/Launch Officer: Commences the countdown and launches the vehicle.
   - Downrange Officer: Observes the launch, measure the height of the rocket at apogee and records data. Spots the rocket and assures the safe landing of the rocket.

8. After launch, back in the class room students should review the results of the test including the height the rocket reached. Students will then redesign the rocket with changes as necessary for the second competition. Again students should be given a clear deadline in order to prepare the rocket for the launch.

9. During the competition independent judges should be used to measure the height the rocket travels.

TEACHER RESOURCES

National Aeronautics and Space Administration. (1996). *Rockets: A Teacher's Guide with Activities in Science Mathematics, and Technology*. Office of Human Resources and Education. Washington, DC.
Online [Available] at http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Rockets/Rockets.pdf