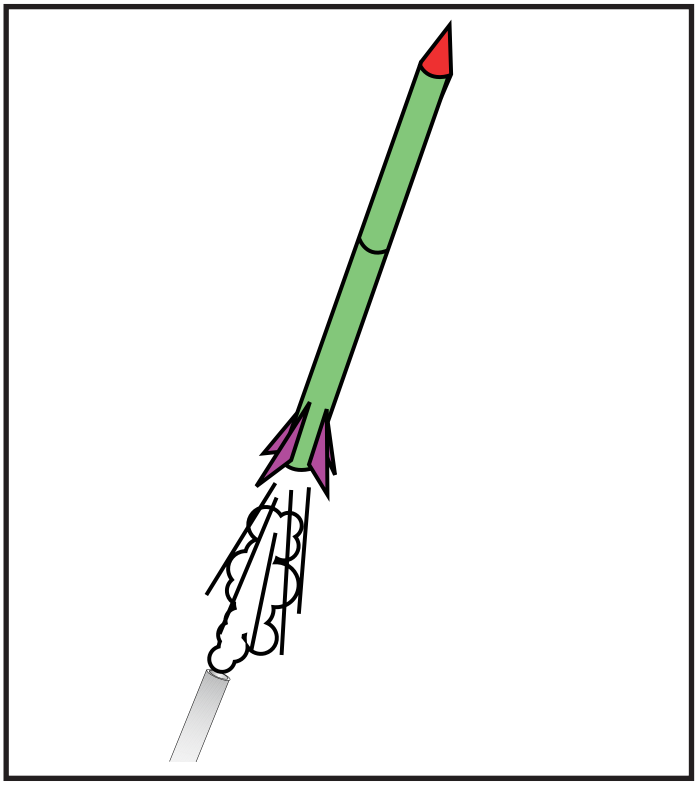


Rocket Activity

Advanced High-Power Paper Rockets

Objective
Design and construct advanced high-power paper rockets for specific flight missions.

Description
Students, working individually or in small teams, select a flight mission (what they want their rocket to do) and design and construct a high-power paper rocket that will achieve the mission. They construct their rocket, predict its performance and the chance of mission success, fly the rocket, and file a post-flight mission report. Missions include achieving high altitude records, landing on a "planetary" target, carrying payloads, testing a rocket recovery system, and more. Instructions are provided for different paper rocket construction techniques.

National Science Content Standards

Unifying Concepts and Processes
- Evidence, models, and explanation
- Change, constancy, and measurement

Science as Inquiry
- Abilities necessary to do scientific inquiry

Physical Science
- Position and motion of objects
- Motions and forces

Science and Technology
- Abilities of technological design

National Mathematics Content Standards
- Number and Operations
- Geometry
- Measurement
- Data Analysis and Probability

National Mathematics Process Standards
- Problem Solving
- Reasoning and Proof
- Communication
- Connections
- Representations

Materials
High-Power Paper Rocket Launcher or Pop Rocket Launcher (See pages 63-65)Paper 8 1/2 X 11 (white or color)
Cellophane tape
White glue
Overhead projector transparency sheets
Ruler
Protractor
Scissors
1/2" PVC pipe 24" long for each rocket builder or team
Eye protection
Mission Report sheet
Other construction materials as required by the team missions

Management

Have students construct and fly a basic paper rocket to help them to become familiar with rocket design and construction techniques (See the preceding activity.) Discuss possible missions with the students and identify what materials will be needed to fulfill their missions. A day or two before construction begins, have students or teams submit mission proposals that identify their mission, what their rocket will look like, how it will function, and what materials are needed for construction.

Demonstrate ways of making heavy duty rockets. Show students how to roll and strengthen a paper tube with white glue. Rockets made with glued body tubes require a couple of days for several applications of glue to dry. Also demonstrate different techniques for making fins, nose cones, and payload stages.

On launch day, post a launch schedule. Organize the schedule so that similar missions are flown consecutively. For example, if the objective is to achieve the greatest altitude, other students will be needed to track the rockets (See the Launch Altitude Tracker activity, page 80).

If students have trouble coming up with flight missions, suggest a few possibilities from the list below:

Maximum Altitude
Precision Landing (basketball planet)
Maximum Distance Downrange
Payload Launch
Parachute Recovery
Longest Air Time

Background

Every space rocket ever built was constructed with a specific mission in mind. The Bumper Project back in the 1950s (See Historical chapter), combined a small WAC Corporal rocket with a V2 to test rocket staging, achieve altitude records, and to carry small payloads for investigating the space environment. The Saturn V was designed to carry astronauts and landing craft to the Moon. The space shuttle was designed as a payload and laboratory carrier for low orbit missions. NASA's new missions into the solar system will require designing rockets with heavy lifting capabilities.

Procedure Double-Long Rocket

1. Overlap, end-to-end, two sheets of paper. Use tape to secure the sheets to each other and roll them around a long PVC tube.
2. Tape the tube and add a nose cone and fins.

Procedure Glue Reinforced Rocket

1. Construct a double-long rocket but do not use tape to seal the long edges. When the paper is partially rolled, squeeze a bead of white glue from one end of the tube to the other. Spread the glue and continue rolling the tube. Add more glue as you roll. Be careful not to get any glue on the PVC.
2. After the tube is dry, smear glue over the entire tube to strengthen it. Several coatings of glue will yield a very strong body tube. (Optional: Mix food coloring into the glue to add color to the rocket.)

Procedure Heavy Duty Fins

1. Extra strong fins can be made by folding and gluing multiple layers of paper together.
2. Cut out the desired fin shape and small flaps for mounting the fins to the body.
3. Smear glue inside the fin and press with a weight to keep the fin flat during drying.
4. Glue the fins to the rocket tube.

Procedure Folded Nose Cone

1. Trace a circle using a CD as a pattern.
2. Fold the circle in half to make a half pie shape.
3. Fold the circle in half twice more to make a 1/4 and a then a 1/8th pie shape.
4. Tape the edges as indicated in the diagram.
5. Spread the nose cone with a finger tip and trim it to fit the rocket. Tape it in place.

Procedure Payload Stage*

1. Roll a rocket body tube. Use paper and tape to close off the upper end of the tube.
2. Roll a second piece of paper around the upper end of the body tube to make a payload stage. Tape it in place. Cut a small

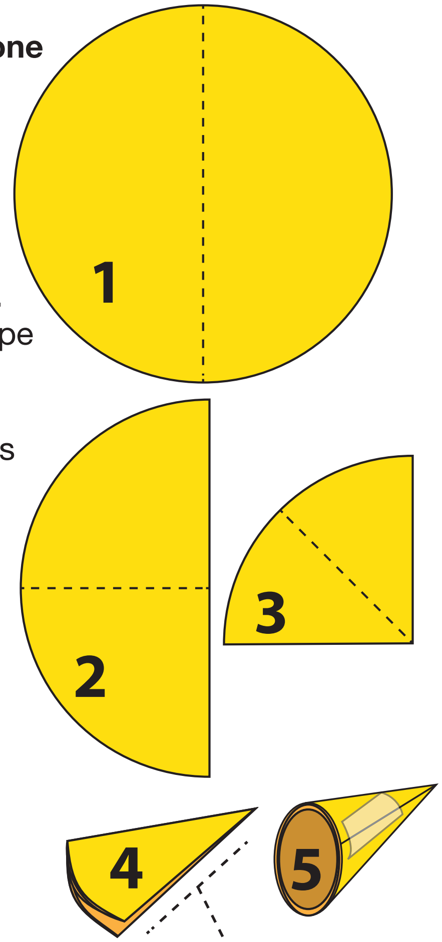
window and slip a tube of overhead projector transparency plastic into the payload stage.
3. Insert the payload and close off the upper end with a standard nose cone.

Procedure Parachute Recovery System*
1. Build a payload stage rocket (without a window). Construct a parachute out of a plastic grocery bag, string, tape, and a metal washer.
2. Place the washer inside the payload stage. Lightly fold and place the parachute on top.
3. Make a nose cone that slips over the payload stage. Do not tape it to the rocket. When the rocket noses over, the weight will separate the nose cone and push out the parachute. (The weight and parachute must slide easily out of the tube or they will get stuck.)

* For a real challenge, consruct your rocket with a parachute recovery system for a payload.

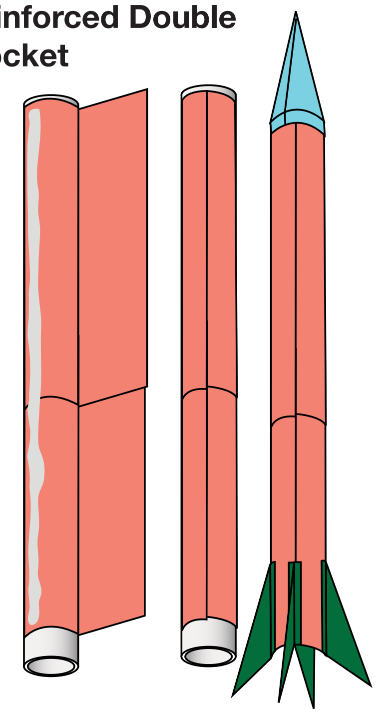
Folded Nose Cone

Cut a circle about 10 cm in diameter. Fold as shown. Tape edges as shown. Spread cone and trim with a scissors to fit rocket tube.

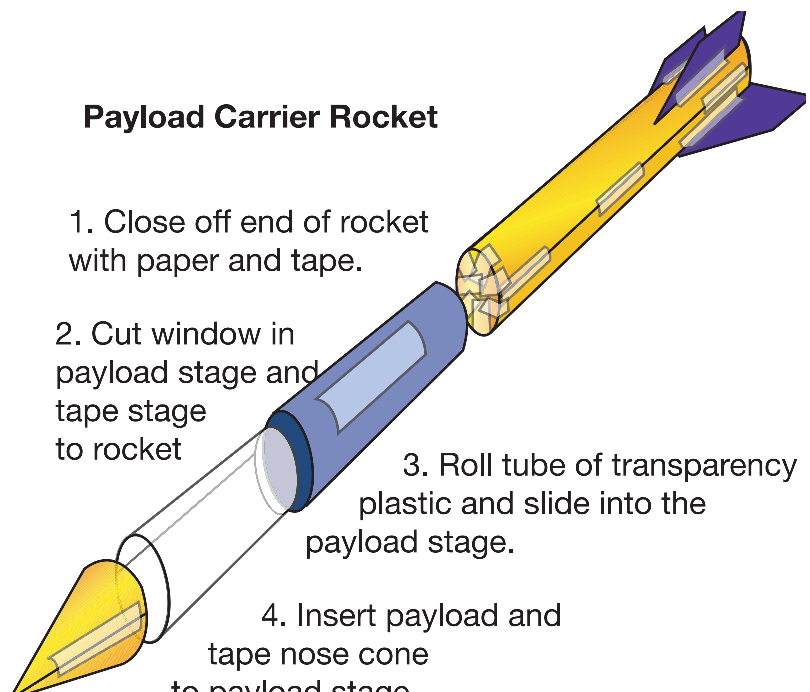


Glue Reinforced Double Long Rocket

Be careful not to glue the paper to the PVC tube!



Payload Carrier Rocket



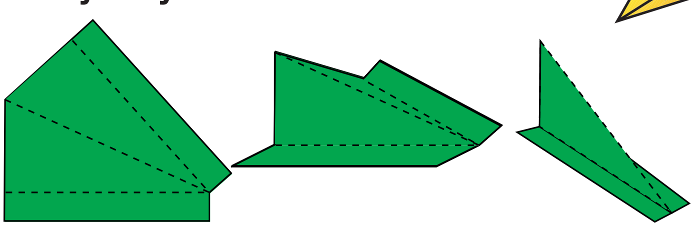
1. Close off end of rocket with paper and tape.

2. Cut window in payload stage and tape stage to rocket

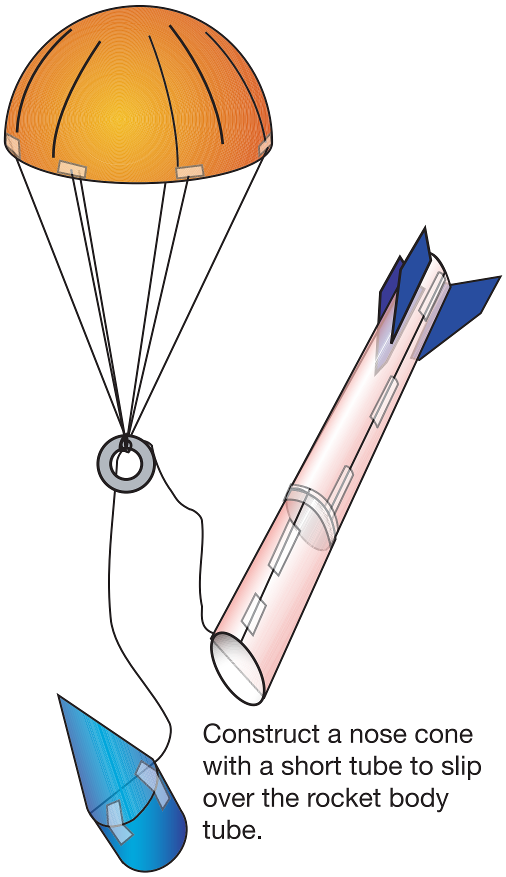
3. Roll tube of transparency plastic and slide into the payload stage.

4. Insert payload and tape nose cone to payload stage.

Heavy Duty Fins



Parachute Recovery System



Discussion

- *Why are rockets designed with specific missions in mind?*
  No one rocket design can meet all the needs of spaceflight missions. If a small satellite is to be launched it is much simpler, less expensive, and safer to use a small unmanned rocket for the job. If a mission to an asteroid is desired, a large rocket with a heavy payload capacity is needed
- *What design feature of the rocket has the greatest effect on flight performance?*
  Air rockets fly through the air and therefore have to be designed to create as little air resistance as possible. Crooked fins or a blunt nose cone increases air drag (friction), causing the rocket to slow quickly. The second most important design feature is weight. Weight is a more complicated factor than streamlining. Too much weight, and the rocket will not fly very high. The same effect takes place if the rocket weighs too little. Crumple a piece of paper into a ball and see how far you can throw it. Crumple a second ball of paper around a nickel throw it again. It will go farther. Very lightweight air rockets have a hard time fighting drag as they fly. Very heavy air rockets have a lot of inertia to overcome.

Assessment

- Evaluate the mission proposals and postflight reports for completeness.
- Have students write a paper on the role drag (friction with the air) plays in the performance of a rocket and how drag can be reduced.
- Have students compare the space shuttle with the new rockets that will be used to travel into the solar system.

Extensions

- Conduct an “X Prize” style competition. The real X Prize competition led to the first non-government reusable manned spacecraft flights to reach outer space. Use the Internet to learn more about the X Prize Foundation and its current programs. Challenge student teams to create a payload-carrying air rocket that can carry a 100-gram (about 50 small paperclips) payload 50 meters into the air.

Mission Proposal

Draw a picture of your proposed rocket

Rocket Scientist Names: ______________________

____

____

What is the name of your rocket? ______________

How long will it be in centimeters? ______________

How many fins will it have? ______________

What special features (if any) will it have?

Describe your mission objective:

How will your rocket achieve its objective?

Provide a detailed list of materials and tools needed to build your rocket (include everything):

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Post-Flight Report

Rocket Scientist Names: ____________________________

____

____

What was your Mission Objective?

Provide the specifications of your rocket:

Rocket total length in cm: ____________________________

Fin span (distance from fin tip to fin tip on other side) in cm: ___________________

Mass of the rocket in g: ______________

(If your rocket carried a payload)

Mass of payload in g: ______________

Describe its flight:

Was your rocket successful in meeting its objectives? ______________________

If not, explain why:

What can you do to improve your rocket's performance?