

Rocket Activity

Heavy Lifting

Objectives

Students construct balloon-powered rockets to launch the greatest payload possible to the classroom ceiling.

Description

Student teams receive identical parts with which they construct their rockets. Drinking straws guide balloon rockets up strings suspended from the ceiling. Teams compete to launch the greatest number of paper clips to space (ceiling).

National Science Content Standards

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
- Data Analysis and Probability

National Mathematics Process Standards

- Problem Solving
- Reasoning and Proof
- Communication
- Connections
- Representations

Materials

Large binder clips (one per launch pad)
 Fishing line or smooth string
 Long balloons (see note on next page about sources)
 Bathroom size (3 oz) paper cup
 2 straight drinking straws
 50 small paper clips
 Sandwich size plastic bag
 Masking tape
 Balloon hand pumps (optional)
 Wooden spring-type clothespins (optional)

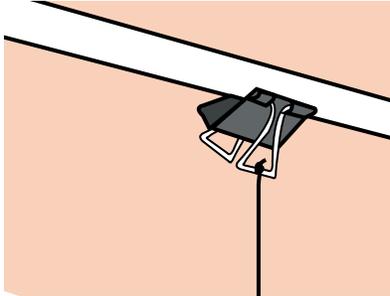
Management

Prepare your classroom by setting up “launch pads” consisting of pieces of fishing line or string suspended from the ceiling (one line per team of students). If your classroom has a suspended ceiling, use binder clips or clothespins to attach to the metal frame supporting the ceiling tiles. Tie the fishing line to the clip or pins. Make sure the line is long enough to reach the floor. Provide open working space around each launch pad.

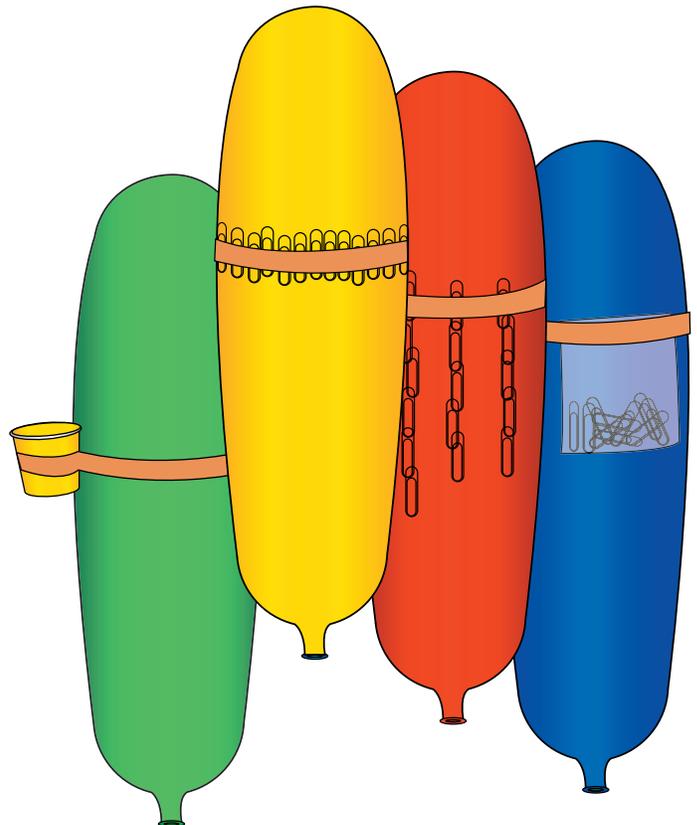
Explain how the straw is used for guiding the rockets. The fishing line or string is fed through the straw and one or more balloons are attached to it with masking tape. When the balloon is released, the straw will ride up the line. Stress that it is very important for students to hold the lower end of the line to the floor. If there is slack in the line or if the lower end of the line is free, the rocket will waffle about and not reach the ceiling.

If you have balloon pumps, demonstrate how they are used to inflate the balloons.

Avoid providing too much information for the students. This is an exercise in creativity, skill, and problem solving. Simply explain the activity, how to use the straws for stability, and tell them that they can use any or all of the parts in their supply kits to build and fly their rockets. The supply kits contain three balloons. Remind students that they only get three balloons.



Binder clip attached to ceiling grid.



Some different ways students may devise to carry the paper clips. The plastic bag can be used too. Let teams come up with their own ideas.

Balloon Sources

Many party supply stores carry variety packs that may include long balloons. Ask if they will special order packs of long balloons for you. The balloons become cylinders 5 inches in diameter and 24 inches long when inflated. They are sometimes called 524 (5 by 24 inches) airships. Find manufacturers and distributors by searching “524 balloons” on the Internet.



Background

NASA’s Constellation program for the next generation of space rockets includes a heavy lift launcher called the *Ares V*. (See pages 13-17 for a detailed description of the rocket and pictures). *Ares V* will carry heavy payloads into orbit, such as very large scientific satellites, space station replacement modules and supplies, and Earth departure stages that will propel human spacecraft to the Moon and Mars.

Raising heavy payloads to orbit is challenging. Rockets require powerful engines and massive amounts of propellants. NASA’s *Ares V* will be able to accomplish the job. It will be one of the largest and most powerful rockets ever built. However, *Ares V* won’t be the only heavy lift vehicle needed. There will be a market for commercial delivery of propellants and modules and robots for constructing tourist hotels, supply delivery, and more. In the future, heavy lift vehicles will become (excuse the expression) a “booming business.”

Procedure

1. Divide your students into teams of three. Explain the project to them.

“NASA is looking for creative ideas for launching heavy payloads into orbit. Payloads include parts and supplies for the International Space Station and spacecraft that will carry humans to the Moon and Mars. NASA is also interested in rockets that can transport large fuel tanks that will be used to power deep space rockets. You are challenged to build the most efficient heavy-lift rocket from the same set of materials. The team that is able to lift the greatest payload into space (the ceiling) is the winner.”

2. Provide each team with an identical kit of materials. Tell them that any or all of these materials can be used for their rockets.
3. Review the launching procedure. Explain how the straw guides the rocket up the fishing line or string and that the line must be held snug to the floor for the launch. Remind the teams that they only get three balloons. They can launch as many times as they want to but should try to improve how many paper clips they can successfully lift.
4. Draw a chart on the board for teams to record their results (i.e., the number of paper clips that reach the ceiling).

Tip If you wish to do so, provide one extra balloon to each team as a replacement in case of a mishap (pop!) or as a fourth rocket for their cluster. Make a small coupon for the extra balloon and put it in the parts bag. The coupons will help you keep track of which teams have already requested an extra balloon.

Discussion

- *Why is NASA supportive of commercial space companies?*

NASA's space efforts are aimed at expanding our horizons in space. Although their space rockets are easily capable of launching communications, weather, and Earth resources satellites, NASA continually looks beyond. NASA explores, and when it pioneers a new technology, it seeks to turn over continued development to U.S. commercial interests. That way, NASA can focus on and advance to the next new horizon. NASA's current new horizons include the first permanent bases on the Moon and the first human expeditions to Mars. These are demanding challenges. When they are met, commercial space companies will follow, permitting NASA to move on to even greater challenges.

- *Why is it important to construct efficient heavy-lift vehicles?*

Traveling into space is a very difficult and expensive endeavor. Huge rockets and tremendous amounts of propellants are required to accomplish the job. With some rockets, launch costs were approximately \$20,000 per kilogram of payload delivered into Earth orbit. If that cost were to continue, imagine staying at a space hotel where it would cost about \$10,000 for a half liter bottle of drinking water! Improving heavy-lift rockets (lighter rocket structures, more propellant efficient engines, etc.) will enable us to accomplish much more in space at far more reasonable costs!

Tip Occasionally, a balloon will have a tiny pinhole that will prevent it from being inflated or from holding air very long. Keep a small supply of replacement balloons.

Assessment

- Have each team describe their design to the class.
 - How many balloons did they use?
 - How many paperclips did their rocket carry to the ceiling?
 - How did they attach the paperclips to the balloon?
 - What problems did they encounter? How did they solve those problems?
- Write a summary of your launch vehicle using correct science and technology terms (e.g., lift, payload, mass, thrust).

Extensions

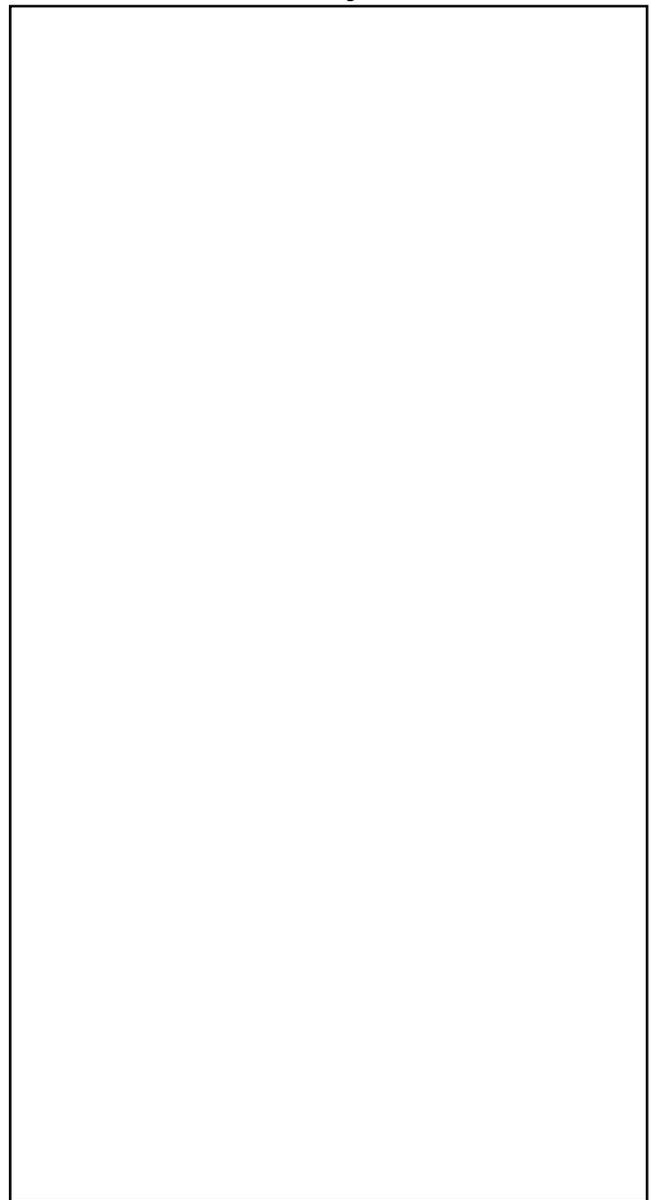
- Challenge students to design a two-stage rocket. The lower balloon “fires” before the upper balloon. The upper balloon carries the payload to the ceiling.

Heavy Lift Rocket Mission Report

Team _____
Member _____
Names: _____

Make a sketch of your best rocket

Flight Test	Predict How Much Mass Your Rocket Will Lift 1 paper clip = 2gm	Actual Mass Lifted
1.		
2.		
3.		
4.		
5.		



Describe your first rocket.

How did you change your rocket to make it carry more mass?

What other ways could you change your rocket to improve it?