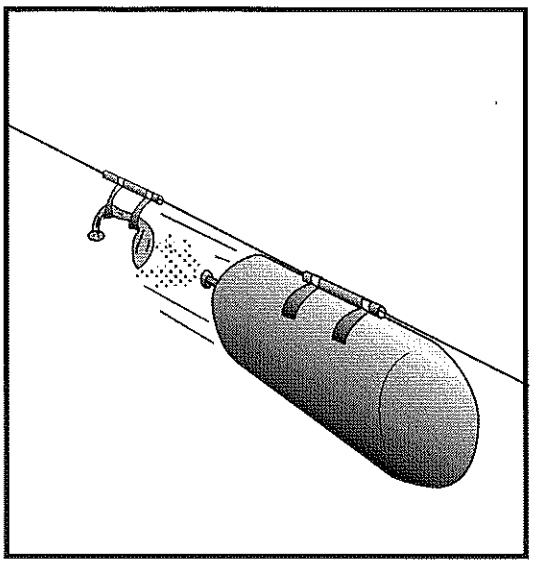


Educator Information

Balloon Staging

Objective:
To demonstrate how rockets can achieve greater altitudes by using the technology of staging.

Description:
This demonstration simulates a multistage rocket launch by using two inflated balloons that slide along a fishing line by the thrust produced from escaping air.

Science Standards:

Physical Science - Position and motion of objects
Science and Technology - Abilities of technological design
Science and Technology - Understanding about science and technology

Science Process Skills:

Observing
Making Models
Defining Operationally

Management:
The activity described below can be done by students or used as a demonstration. Younger students may have difficulty in coordinating the assembly steps to achieve a successful launch. If you will use the activity in several successive classes, consider attaching the fishing line along one wall where there is not much traffic, so students will not walk into the line.

Background Information:
Traveling into outer space takes enormous amounts of energy. This activity is a simple demonstration of rocket staging that Johann Schmidlap first proposed in the 16th century. When a lower stage has exhausted its load of propellants, the entire stage drops away, making the upper stages more efficient in reaching higher altitudes. In the typical rocket, the stages are mounted one on top of the other. The lowest stage is the largest and heaviest. In the Space Shuttle, the stages attach side by side. The solid rocket boosters attach to the side of the external tank. Also attached to the external tank is the Shuttle orbiter. When exhausted the solid rocket boosters jettison. Later, the orbiter discards the external tank as well.

Procedure:

1. Thread the fishing line through the two straws. Stretch the fishing line snugly across a room and secure its ends. Make sure the line is just high enough for people to pass safely underneath.
2. Cut the coffee cup in half so that the lip of the cup forms a continuous ring.
3. Stretch the balloons by pre-inflating them.

Materials and Tools:

- 2 Long party balloons
- Nylon monofilament fishing line (any weight)
- 2 Plastic straws (milkshake size)
- Styrofoam coffee cup
- Masking tape
- Scissors
- 2 Spring clothespins

Inflate the first balloon about three-fourths full of air and squeeze its nozzle tight. Pull the nozzle through the ring. Twist the nozzle and hold it shut with a spring clothespin. Inflate the second balloon. While doing so, make sure the front end of the second balloon extends through the ring a short distance. As the second balloon inflates, it will press against the nozzle of the first balloon and take over the clip's job of holding it shut. It may take a bit of practice to achieve this. Clip the nozzle of the second balloon shut also.

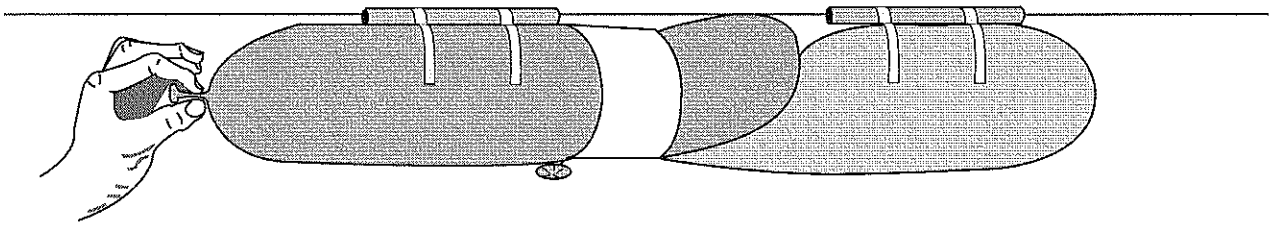
4. Take the balloons to one end of the fishing line and tape each balloon to a straw with masking tape. The balloons should point parallel to the fishing line.
5. Remove the clip from the first balloon and untwist the nozzle. Remove the nozzle from the second balloon as well, but continue holding it shut with your fingers.
6. If you wish, do a rocket countdown as you release the balloon you are holding. The escaping gas will propel both balloons along the fishing line. When the first balloon released runs out of air, it will release the other balloon to continue the trip.
7. Distribute design sheets and ask students to design and describe their own multistage rocket.

Assessment:

Collect and display student designs for multistage rockets. Ask each student to explain their rocket to the class.

Extensions:

- Encourage the students to try other launch arrangements such as side-by-side balloons and three stages.
- Can students fly a two stage balloon without the fishing line as a guide? How might the balloons be modified to make this possible?



Design Sheet

Design a rocket that has at least two stages. In the space below, describe what each stage will do. Do not forget to include a place for payload and crew.

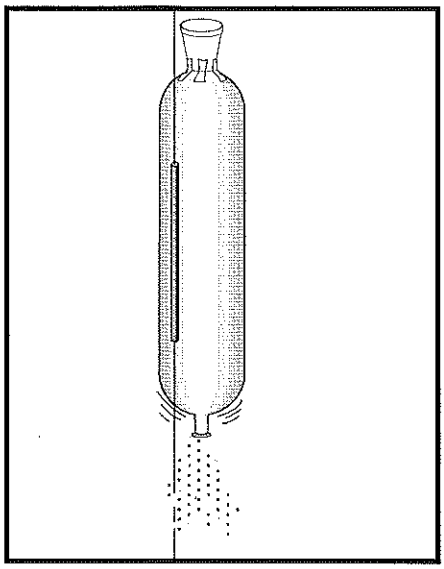
Top View

Description

Your Name: _____

Rocket Name: _____

Side View



Educator Information

Rocket Transportation

Objective:
To problem solve ways to lift a load using a balloon rocket.

Description:
Students construct a rocket out of a balloon and use it to carry a paper clip payload.

Science Standards:
- Science as Inquiry
- Physical Science - Position and motion of objects
- Science and Technology - Abilities of technological design

Science Process Skills:
- Observing
- Communicating
- Measuring
- Collecting Data
- Inferring
- Predicting
- Making Models
- Controlling Variables
- Defining Operationally
- Investigating

Mathematics Standards:
- Problem Solving
- Communication
- Reasoning
- Connections
- Estimation
- Measurement

Management:
This activity works best with students working in teams of three or four. It will take approximately one hour to complete. The activity focuses on the scientific processes of experimentation.

Background Information:

The mass of a rocket can make the difference between a successful flight and a rocket that just sits on the launch pad. As a basic principle of rocket flight, a rocket will leave the ground when the engine produces a thrust that is greater than the total mass of the vehicle.

Large rockets, able to carry a spacecraft into space, have serious weight problems. To reach space and proper orbital velocities, a great deal of propellant is needed; therefore, the tanks, engines, and associated hardware become larger. Up to a point, bigger rockets fly farther than smaller rockets, but when they become too large their structures weigh them down too much.

Materials and Tools:
- Large long balloons (Several per group)
- Fishing line
- Straws
- Small paper cups
- Paper clips
- Tape
- Clothes pins
- Scales

A solution to the problem of giant rockets weighing too much can be credited to the 16th-century fireworks maker John Schmidlap. Schmidlap attached small rockets to the top of big ones. When the large rockets exhausted their fuel supply the rocket casing dropped behind and the remaining rocket fired. Much higher altitudes can be achieved this way.

This technique of building a rocket is called staging. Thanks to staging, we can not only reach outer space in the Space Shuttle, but also the Moon and other planets using various spacecraft.

Procedure:

1. Attach a fishing line to the ceiling or as high on the wall as possible. Try attaching a paper clip to a fishing line and hooking it on to the light or ceiling tile braces. Make one drop with the fishing line to the floor or table top per group. Note: The line may be marked off in metric units with a marker to aid students in determining the height traveled.
2. Blow up the balloon and hold it shut with a clothes pin. You will remove the clip before launch.
3. Use the paper cup as a payload bay to carry the weights. Attach the cup to the balloon using tape. Encourage students to think of creative locations to attach the cup to the balloon.
4. Attach the straw to the side of your rocket using the tape. Be sure the straw runs lengthwise along the balloon. This will be your guide and attachment to your fishing line.
5. Thread the fishing line through the straws. Launch is now possible simply by removing the clothes pin. NOTE: The fishing line should be taut for the rocket to travel successfully up the line, and the clipped balloon nozzle must be untwisted before release.
6. After trying their rocket have students predict how much weight they can lift to the ceiling. Allow students to change their design in any way that might increase the rockets lifting ability between each try (e.g. adding additional balloons, changing locations of the payload bay, replacing the initial balloon as it loses some of its elasticity enabling it to maintain the same thrust, etc.)

Discussion:

1. Compare what you have learned about balloons and rockets.

2. Why is the balloon forced along the string?

Assessment:

Compare results from student launches. Have students discuss design elements that made their launch successful and ideas they think could be used to create an even more successful heavy-lift launcher.

Extensions:

- Can you eliminate the paper cup from the rocket and have it still carry paper clips?

- If each balloon costs one million dollars and you need to lift 100 paper clips, how much money would you need to spend? Can you think of a way to cut this cost?

- Without attaching the paper cup as a payload carrier, have the students measure the distance the balloon travels along the string in a horizontal, vertical, and 45 degree angle using metric units. Discuss the differences.

Rocket Transportation

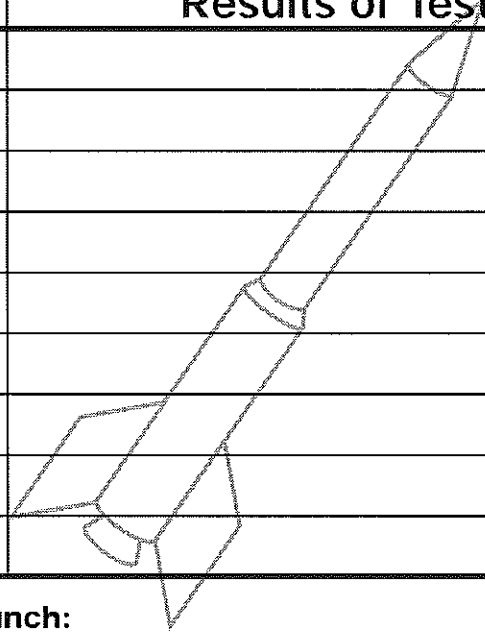
Rocket Team _____

_____

_____

- Predict how much weight your rocket can lift to the ceiling _____
  (2 small paperclips = approximately 1 gram)

Test	Weight Lifted	Results of Test
1		
2		
3		
4		



Based on your most successful launch:

•What was the maximum amount of weight you could lift to the ceiling?_____

Sketch Your Rocket

Explain how you designed your rocket to lift the maximum amount of weight.

_____

_____

_____

_____

_____

_____

_____

- What other ways could increase the lifting capacity of your rocket?

_____