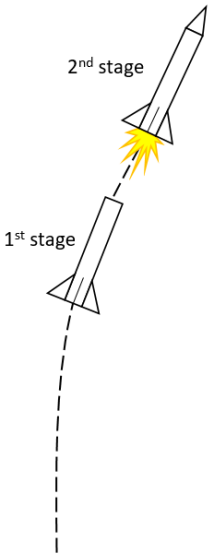
Two-Stage Balloon Rocket Activity

Introduction



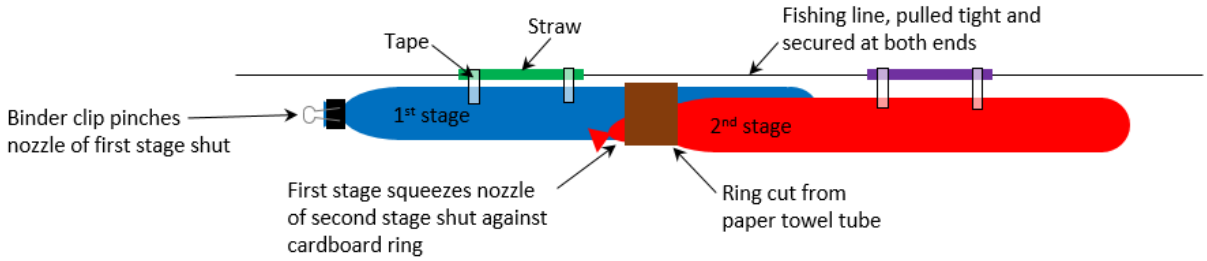
Think about how much energy it takes to carry a heavy backpack up a mountain when hiking. You would not want to carry any unnecessary weight or extra gear all the way to the top of the mountain, because it would be a waste of energy. The same concept applies to launching rockets into space. Have you ever watched a rocket launch on TV, and noticed that some parts of the rocket fall away and burn up in the atmosphere? This is called a multi-stage rocket launch. A large first stage boosts the rocket through the first part of its flight. Then, it breaks away, and a smaller rocket continues to travel into space. This approach allows the second rocket to use less fuel so it doesn't have to drag along all the extra weight of the first rocket. It takes a *lot* of energy to get things into orbit, so every bit of fuel you can save counts! In this project you will build your own two-stage rocket using balloons. How far can you get it to travel?

Materials (per group of 2-4 students)

- 2 modeling balloons (the long, skinny kind used to make balloon animals). Have extras handy in case some balloons pop.
- 2 milkshake straws (not the bendy kind)
- 1 inch section cut from paper towel tube
- Fishing line or smooth string—length will depend on size of classroom
- Clear tape or masking tape
- Scissors
- Balloon pump
- 2 large binder clips

Procedure

1. Cut a piece of fishing line long enough to stretch across the room, with enough extra to tie it on both ends.
2. Thread the fishing line through two straws, pull it tightly across the room, then secure it at both ends (for example, tie it to two heavy pieces of furniture).
3. Cut a small ring (slightly less than one inch long) from the paper towel tube.
4. Stretch the balloons to loosen them before inflating.
5. Inflate one balloon about 1/2 to 3/4 full. Do not inflate the balloon so much that it starts to bend significantly. Use a binder clip to pinch the balloon's nozzle shut so it doesn't deflate.
6. Pull the balloon's nozzle through the cardboard ring, keeping it clipped shut.
7. Thread another balloon partially through the cardboard ring. Make sure its nozzle is facing the same direction as the first balloon. Note that the first balloon you inflated will be the *second* stage of your rocket, and vice versa.
8. This is the hard part; be patient! Inflate the second balloon such that it presses up against the inside of the cardboard ring, squeezing the nozzle of the other balloon shut (see diagram). You should be able to remove the binder clip from the first balloon and have it stay inflated. This may take a few tries; if you have problems getting the first balloon to stay inflated, see the Troubleshooting section.
9. Use a binder clip to pinch the nozzle of the second balloon shut, and tape the balloons to the straws. Make sure the balloons and straws are pointed in a straight line.
10. Pull the balloons to one end of the fishing line, and remove the binder clip from the second balloon. Observe what happens.
11. To reset your rocket, repeat steps 5-10. Can you make changes and get it to go farther?

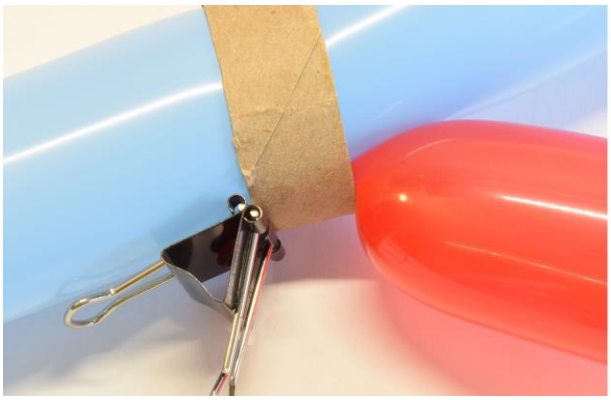


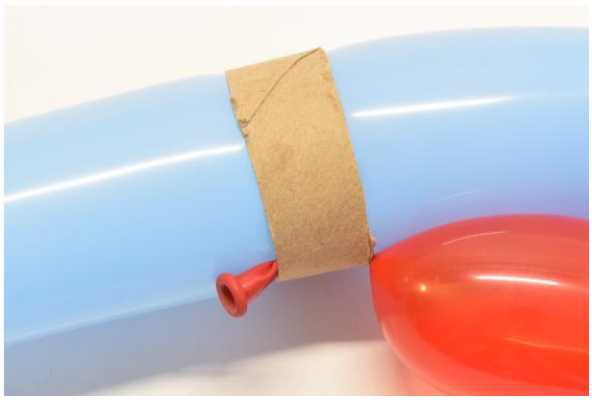
What You Should See

The two balloons behave like two stages of a rocket. When you release the nozzle of the first stage, air escapes out the back of the balloon. According to Newton's third law of motion, for every action, there is an equal and opposite reaction—this means the balloon is pushed forward along the string. Initially, the first stage keeps the nozzle of the second stage pinched shut. When the first stage deflates, air starts escaping from the second stage, which continues to travel forward like the second stage of a rocket—without dragging along the dead weight of the deflated first stage.

Troubleshooting

It can be hard to get your rocket to work on the first try—don't get frustrated! You might need to adjust how much you inflate the balloons, how far you push them through the cardboard tube, and where you tape them to the straws. If you have trouble getting the first balloon you inflate to stay sealed, try keeping its nozzle pinched shut with a binder clip until right before you launch your rocket, or twisting the balloon a couple times to help seal the nozzle:





Do your best to make sure the balloons and straws remain in a straight line. If the balloons are curved or not aligned with each other, this will introduce extra friction along the fishing line and slow your rocket down. Stretching the balloons before you blow them up will help them inflate evenly instead of curving. Also make sure the balloons' nozzles are pointed along the fishing line, so the balloons are pushed forward when the air escapes. If the nozzles are pointed sideways, they will not push the balloons forward (remember Newton's third law!). You may need to experiment with the best location to tape the balloons to the straws, and you can also try taping the cardboard ring to one of the straws.