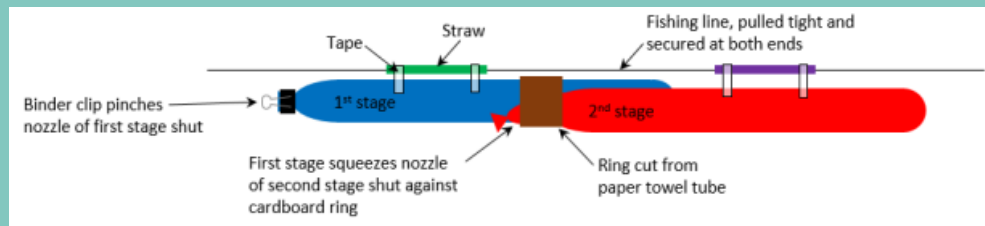


Two-Stage Balloon Rocket

Materials



Procedure



1. Cut the straw into 1-inch pieces.
2. Thread two pieces of straw on the fishing line.
3. Find 2 strong objects between 80 and 100 feet apart and tie the ends of this fishing line to these strong objects. The fishing line should be well stretched.
4. Cut a small ring (slightly less than one inch long) from the paper towel tube.
5. Stretch the balloons to loosen them before inflating.
6. 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.
7. Pull the balloon's nozzle through the cardboard ring, keeping it clipped shut.
8. 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.
9. **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 above). You should be able to remove the binder clip from the first balloon and have it stay inflated. This may take a few tries.
10. Refer to troubleshooting section if step 9 is challenging
11. 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.
12. Pull the balloons to one end of the fishing line and remove the binder clip from the second balloon. Observe what happens.
13. To reset your rocket, repeat steps 5-11. **Can you make changes and get it to go farther?**

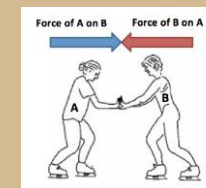
What Do You Learn?

Basic Principle: Newton's 3rd Law!

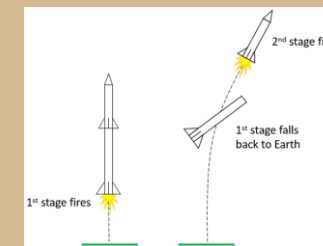
“Every action has an equal opposite reaction”

All forces between 2 objects exist in equal magnitude & opposite direction

$$F_A = F_{-B}$$



How Does it Work?



- The plastic ring is a solid object against which the mouth of the first balloon is pressed.
- That pressure holding the air of the first balloon is temporarily maintained by four fingers until the pressure of the soon-to-be inflated second balloon takes over.
- Letting go of the balloon allows the high-pressure air to rush out into the less pressurized air around it. But this rushing out provokes an opposite force, which propels the rocket forward
- The same process is repeated when the first stage is depleted and it's the turn of the second stage to push ahead.

Two-Stage Balloon Rocket

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.

