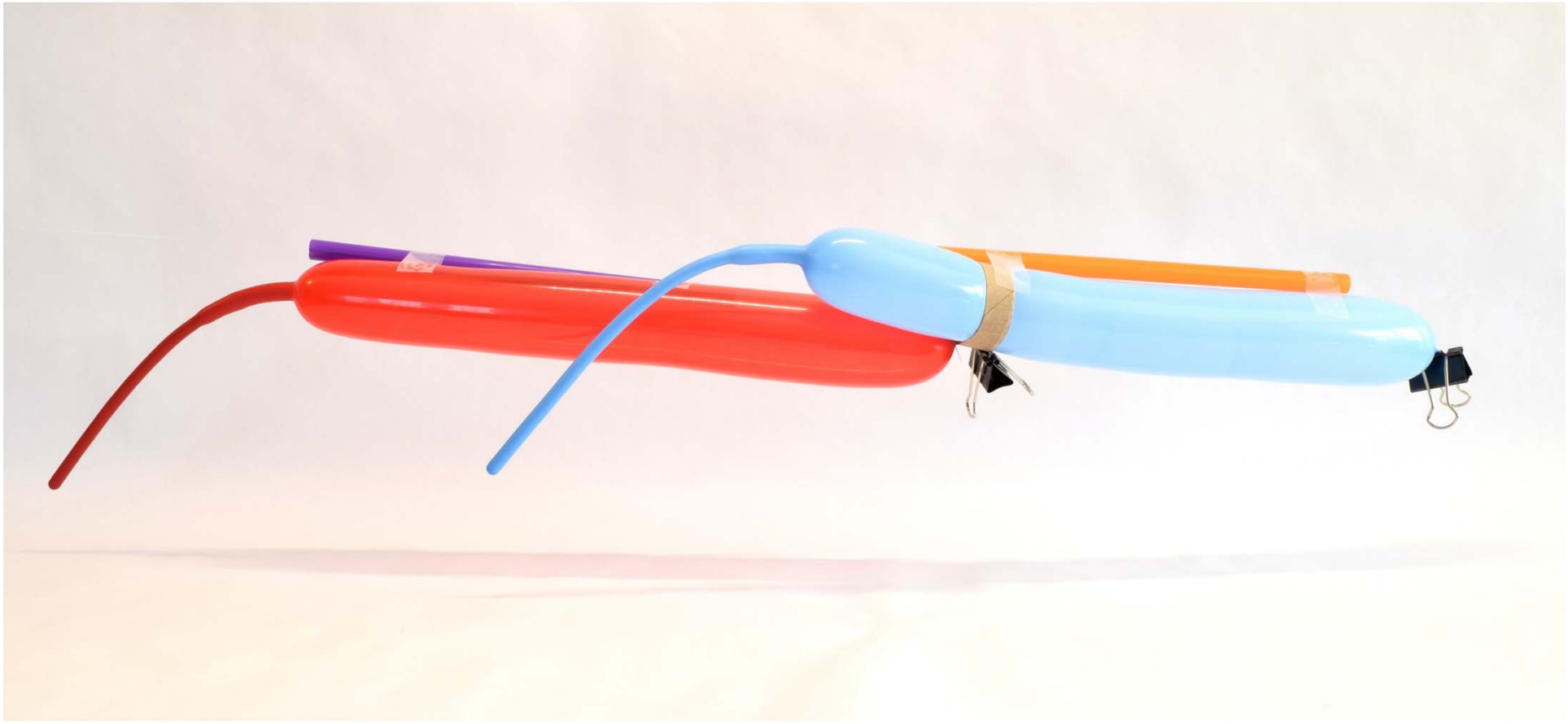
Two-Stage Balloon Rocket

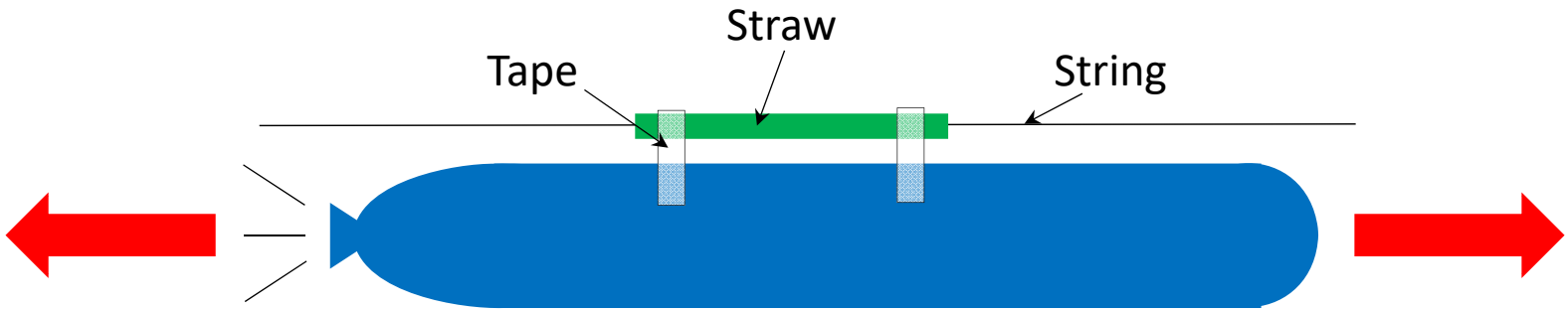


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Balloon Rockets

- Newton's third law: for every action, there is an equal and opposite reaction

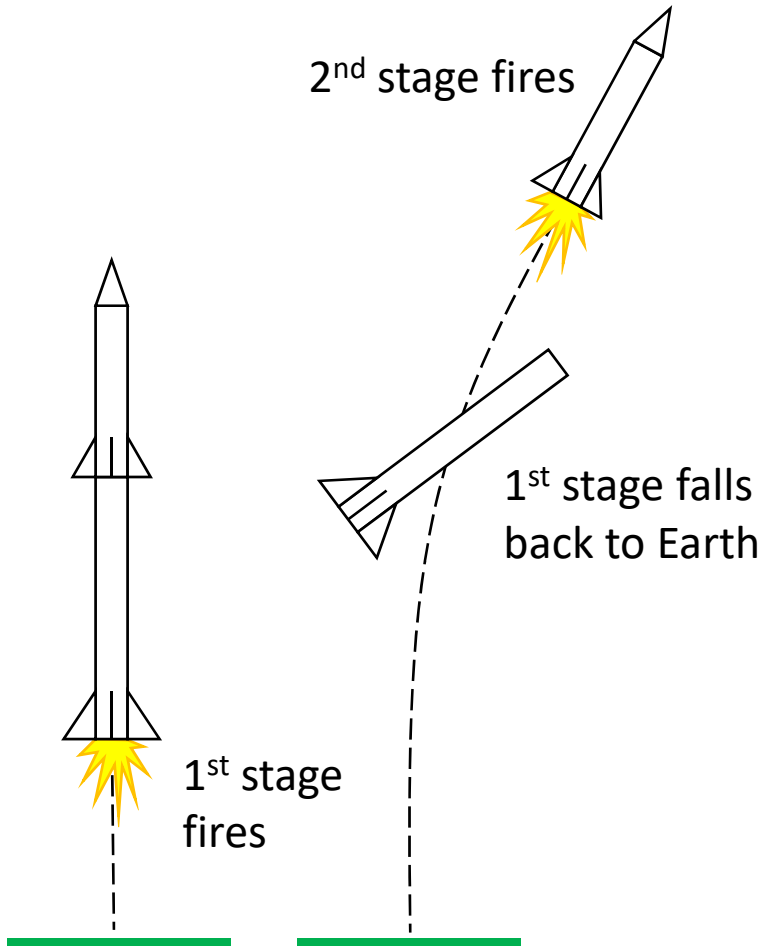


Air is pushed out the back of the balloon

The balloon is pushed forward

Real life two-stage rockets

- First stage lifts rocket through beginning of flight
- First stage breaks away and falls back to Earth
- Second stage continues flight into space
- Saves energy because second stage doesn't have to carry extra weight of depleted first stage



Example: NASA's Space Launch System (SLS)

First stage:



Booster separation:

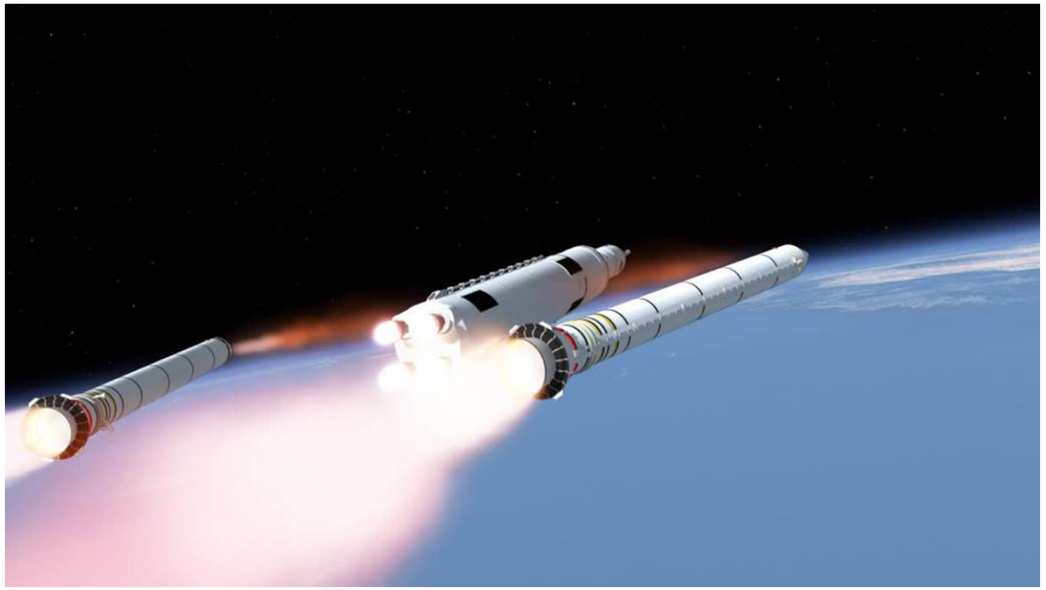
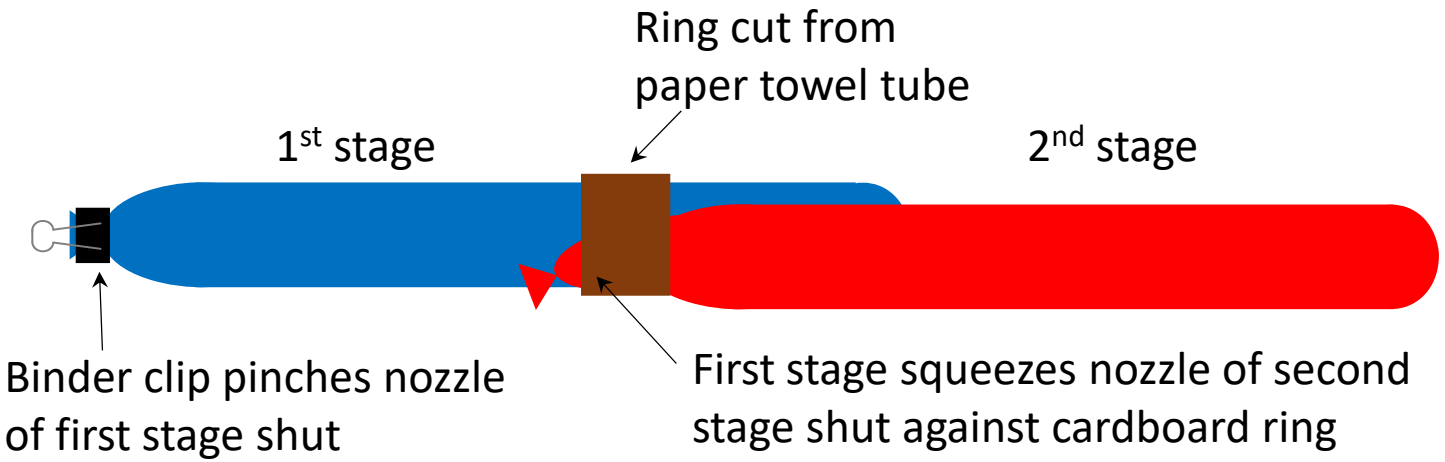


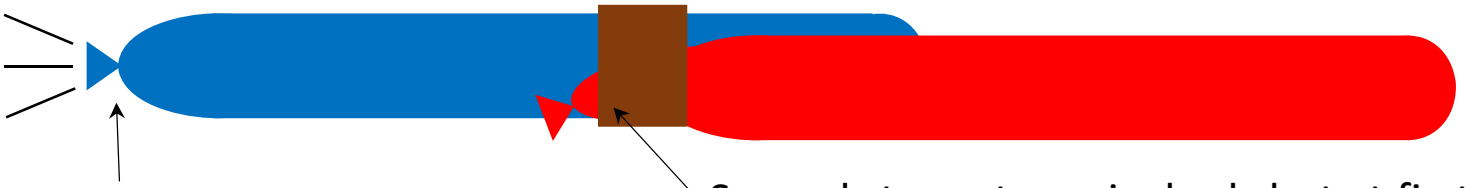
Image credits: NASA

How could you build a two-stage balloon rocket?

How could you build a two-stage balloon rocket?



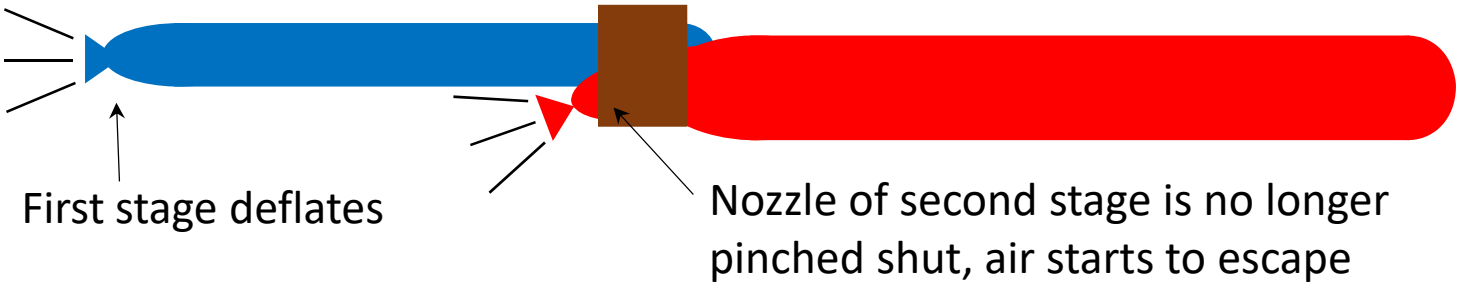
How does it work?



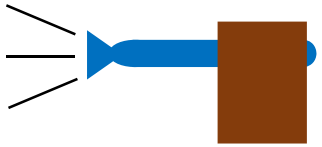
Remove the binder clip – air escapes from the first stage and pushes both balloons

Second stage stays pinched shut at first

How does it work?



How does it work?



First stage gets left behind



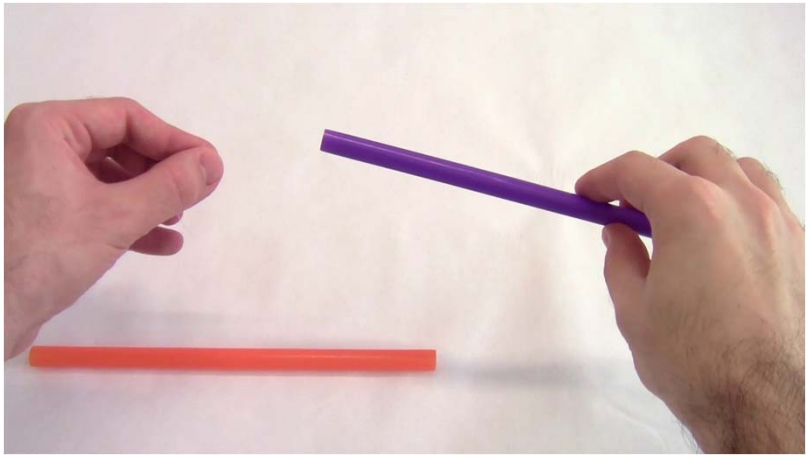
Second stage continues moving

Materials

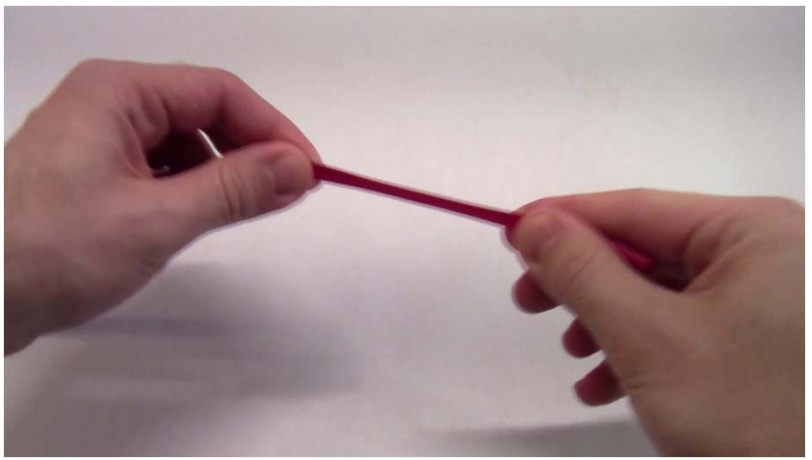

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ULTIMATE STRENGTH AND SENSITIVITY!
ROBUSTESSE ET SENSIBILITE OPTIMALES!
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12 lb
5.4kg
274m
0.30mm
300 YD .012in Avg. Dia.
Matte Finish
Magic Tape
Scotch
3M

Setup

- Thread fishing line through two straws
- Tie fishing line tightly across classroom
- Cut a small section (less than 1 inch) from the paper towel tube
- Stretch balloons to loosen them before inflating







Build your rocket

- Inflate first balloon at least halfway (don't inflate it so much that it starts to curve)
- Pinch its nozzle shut with binder clip
- Thread nozzle through cardboard ring

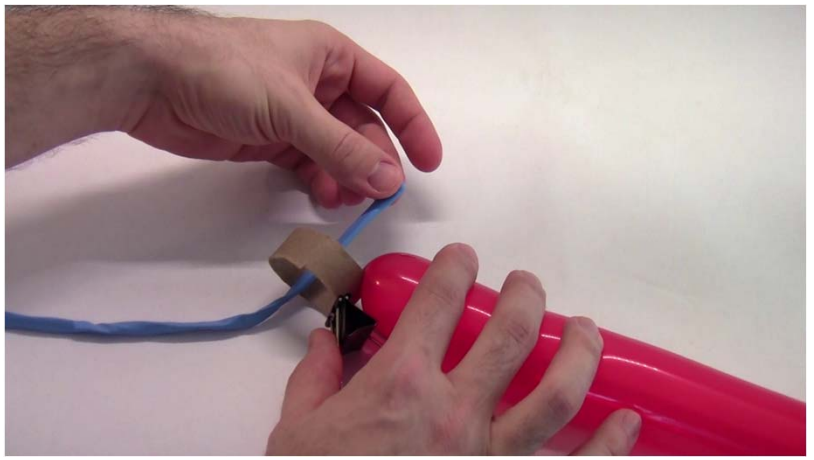






Build your rocket

- Thread second balloon partially through cardboard ring
- Inflate second balloon so it pinches nozzle of first balloon shut
- You should be able to remove the binder clip without the balloon deflating
- Be patient – this can be difficult! Try twisting the first balloon a few times, this may help
- Much easier with two people
- Use another binder clip to pinch the nozzle of the second balloon shut

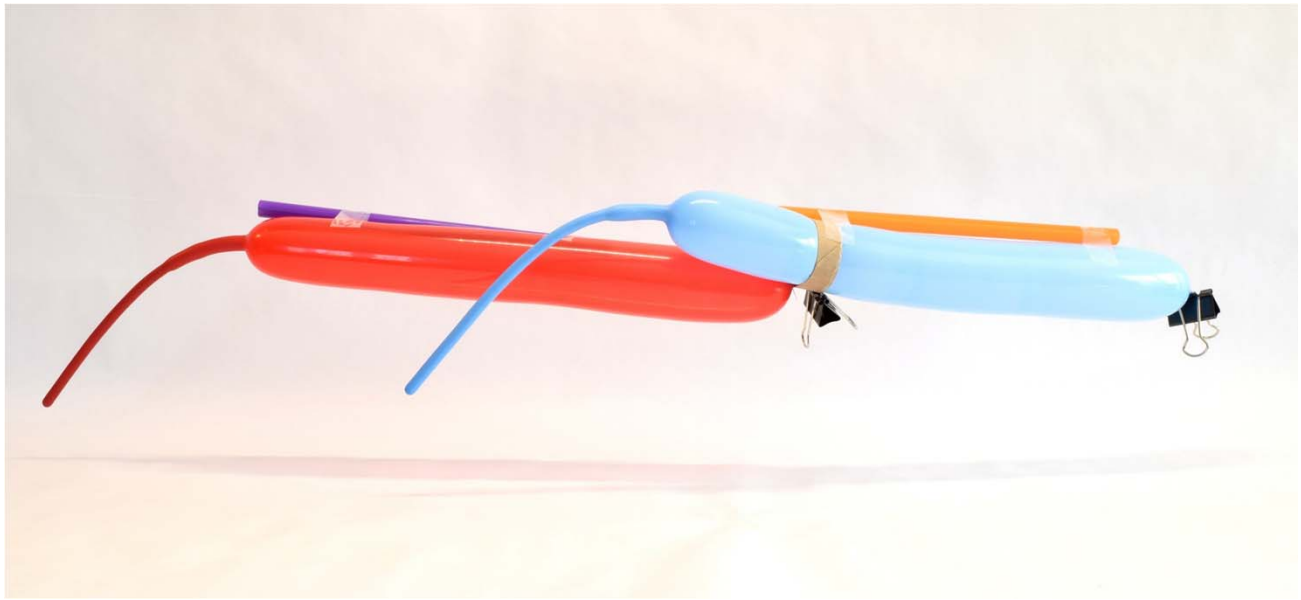






Attach to fishing line

- Tape the balloons to the straws
- Try to keep the balloons and straws pointed in a straight line
- Don’t tape the balloons to each other – this will prevent the stages from separating!
- Might need to experiment with exactly where you put the tape (you can also tape the cardboard ring to a straw)
- Note: the first balloon you inflated becomes the second stage of your rocket, and vice versa



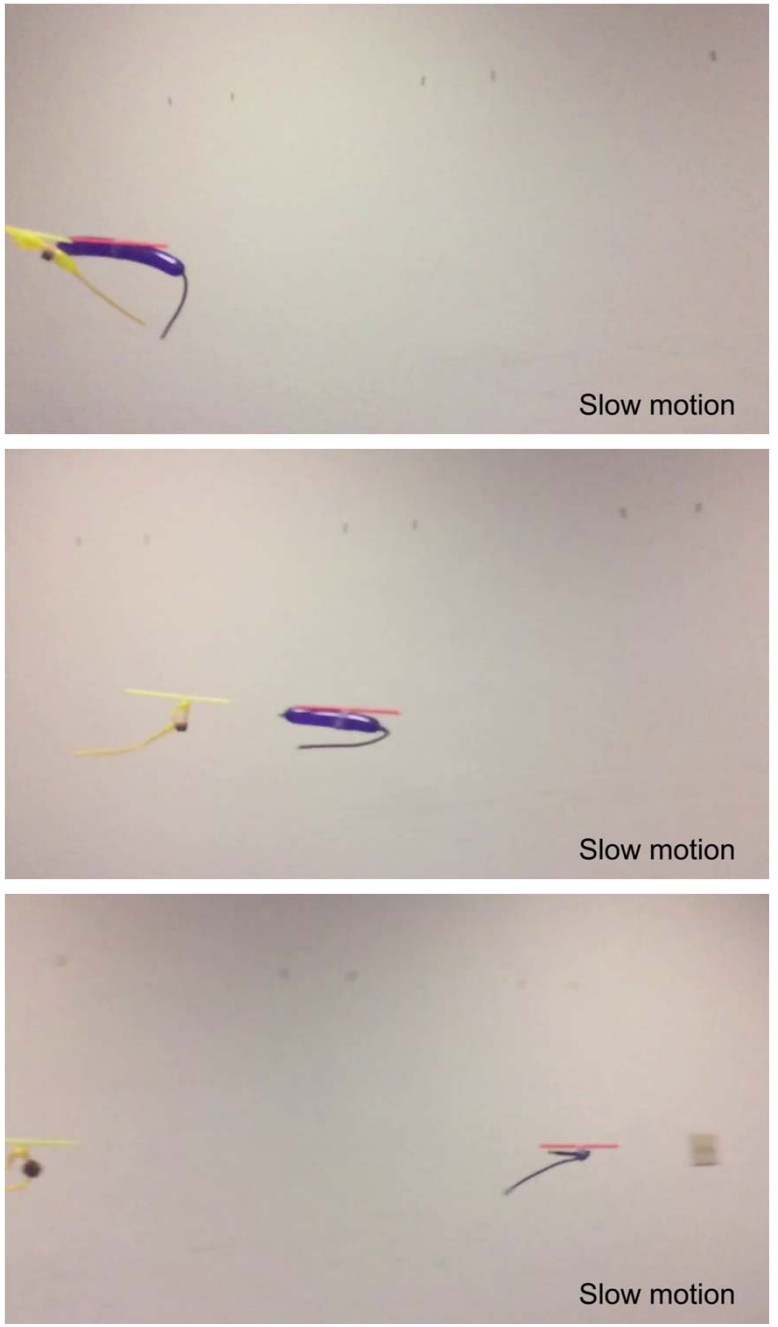
Launch!

- Pull both balloons to one end of the fishing line
- Get ready to release the nozzle of the first stage – what do you think will happen?

Snapshots from slow-motion video

Launch!

- Pull both balloons to one end of the fishing line
- Get ready to release the nozzle of the first stage – what do you think will happen?
- Your balloons should rocket along the string:
  - The first stage deflates, pushing both balloons
  - The second stage starts to deflate when its nozzle is no longer pinched shut
  - The second stage continues moving without the first stage



Snapshots from slow-motion video

Troubleshooting

- Don’t get frustrated if your rocket doesn’t work on the first try! Here are some things to watch out for:
- The second stage might deflate early if its nozzle isn’t initially pinched shut all the way. Leave the binder clip in place until the last second if necessary.
- If the balloons and straws are not in a straight line, this can cause extra friction along the fishing line and slow your rocket down.

