Forces acting on a moving rocket

By Doaa George, based on the workshop investigation by Nicoleta Maynard and Annabel Kannakis

Figure 1 – Atlas V Rocket Launches with Juno Spacecraft

Introduction

The beauty of the laws of physics lies in their application in our daily lives. Without the physical sciences, we would never be able to launch rockets into outer space nor maintain satellites in orbit around the Earth or other planets.

Our current living standard depends on these artificial satellites in a number of ways. For example, the GPS (Global Positioning System) is a satellite that is used to help us find our way to different destinations. Weather satellites send us the data required to predict the weather. This is extremely important when warnings are given in cases of severe storms and hurricanes to help people find shelter and evacuate potentially dangerous areas. Satellites are also used in communications, such as those used for mobile communications and television and radio signals. To place a satellite in its desired orbit, they are attached to a rocket and launched into space. Once they reach their destination, they are detached from the rocket. In this study, you will learn about Newton's laws of motion in order to understand the different forces acting on a rocket being launched into space.

Risk analysis

- Use a blow pump to blow the balloon if it is available. If you need to use your mouth, make sure the balloon you use is new from the package to avoid catching germs.
- Ensure to double knot the string when being tied to something to avoid it coming apart.
- Clear the area around the experiment set-up, especially from any glassware, to avoid breakage in case of an accident.

Questions

- What are Newton's laws of motion?
- How do we apply Newton's laws of motion to the movement of the balloon?
- How is this experiment related to the forces acting on a rocket?

Aim

You will use a balloon model to explain the different forces that act on the rocket. After doing the experiment you are expected to be able to explain practical applications of Newton's laws of motion.

Plan

Form groups of three and follow the instructions given to make the necessary measurements.

Materials

- 1 plastic drinking straw
- 1 plastic bag, about the size of an inflated balloon
- Fishing line or string (nylon [slippery] strings works better than twine [rough])
- 1 balloon
- Tape measure

Conduct

Decide with your group members the role of each student in the experiment in order to have a well organised set up and to get the best possible results.

Procedure

- Tape a drinking straw along the side of a plastic bag (see figure 2).
- Thread the string through the straw.
- Tie each end of the string to a chair, and pull the chairs apart so that the string is taut.
- Position the bag at one end of the string, with the open end of the bag facing toward the chair.
- Blow up a balloon and put it into the bag, holding the balloon closed.
- Count down to zero, and let go of the balloon…ZOOOOOOM!
- Measure the distance your balloon rockets travelled on the string and answer the questions provided.
- As a class, review and discuss your answers.

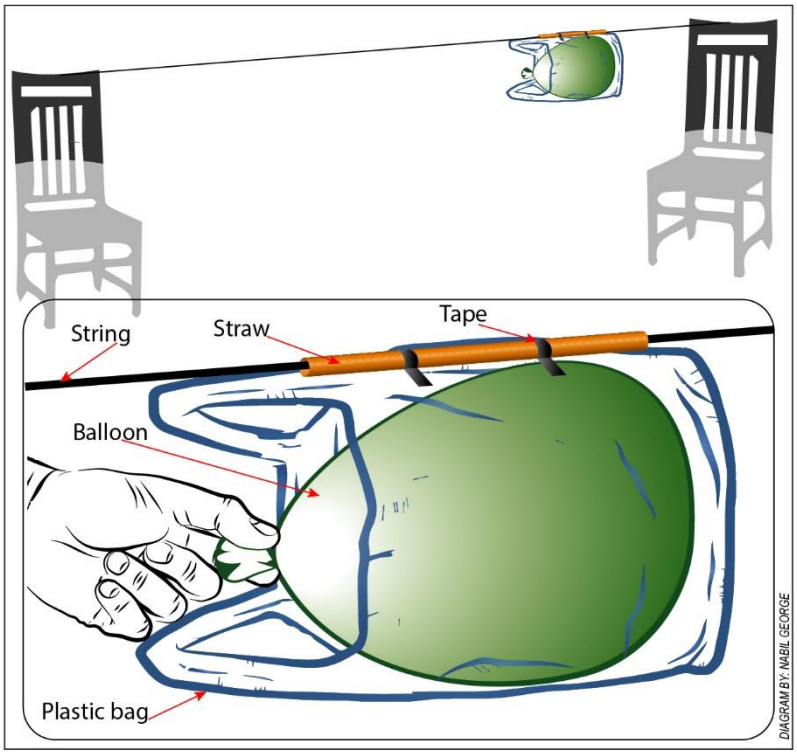


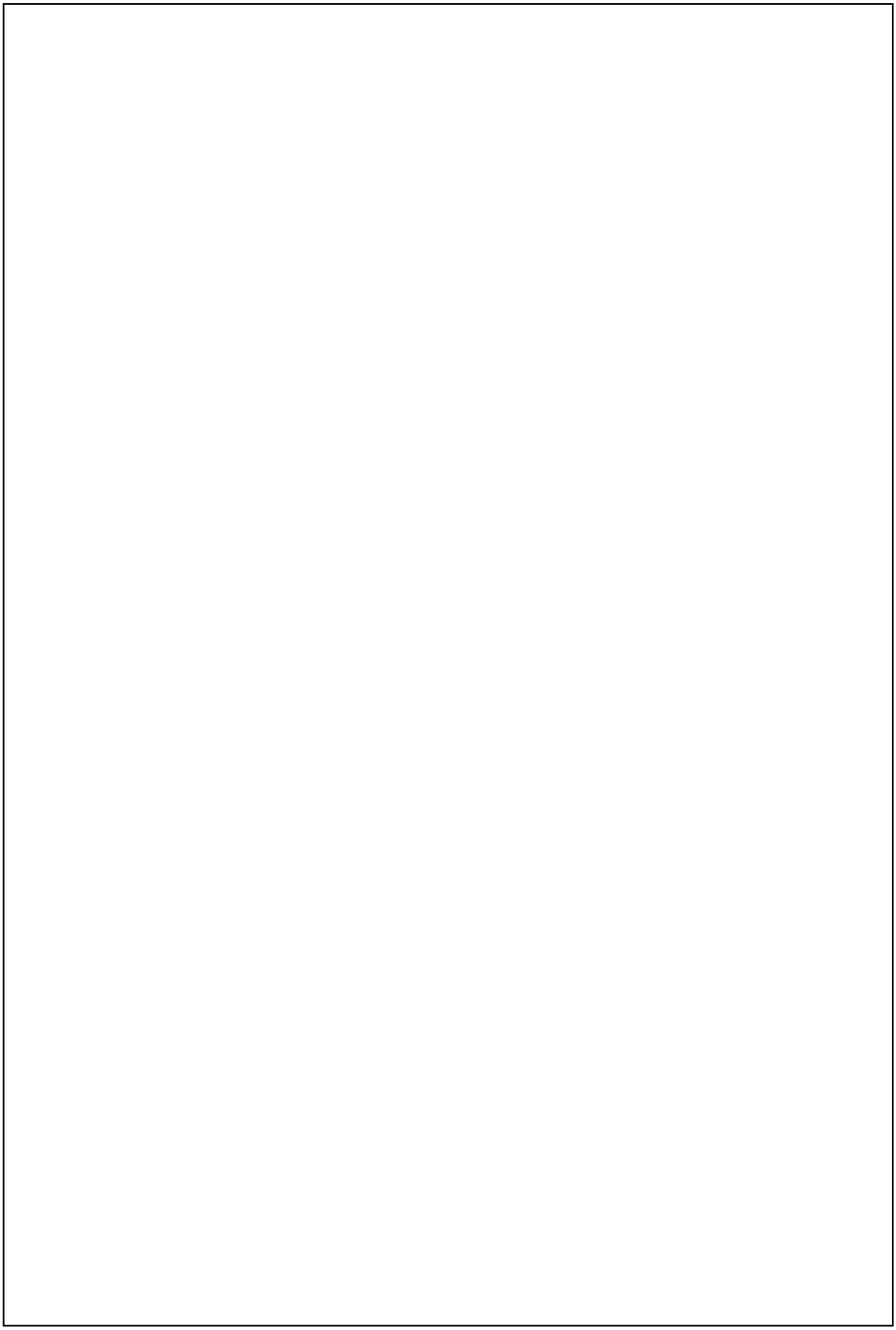
Figure 2 – the setup of the experiment

Analysis

- Predict the distance travelled along the string for a balloon that is filled with air. Do this for balloons that have been blown up to a small, medium and large size. Then, record the actual distances travelled during three trials for each size balloon.

Balloon size	Trial	Predicted distance	Actual distance

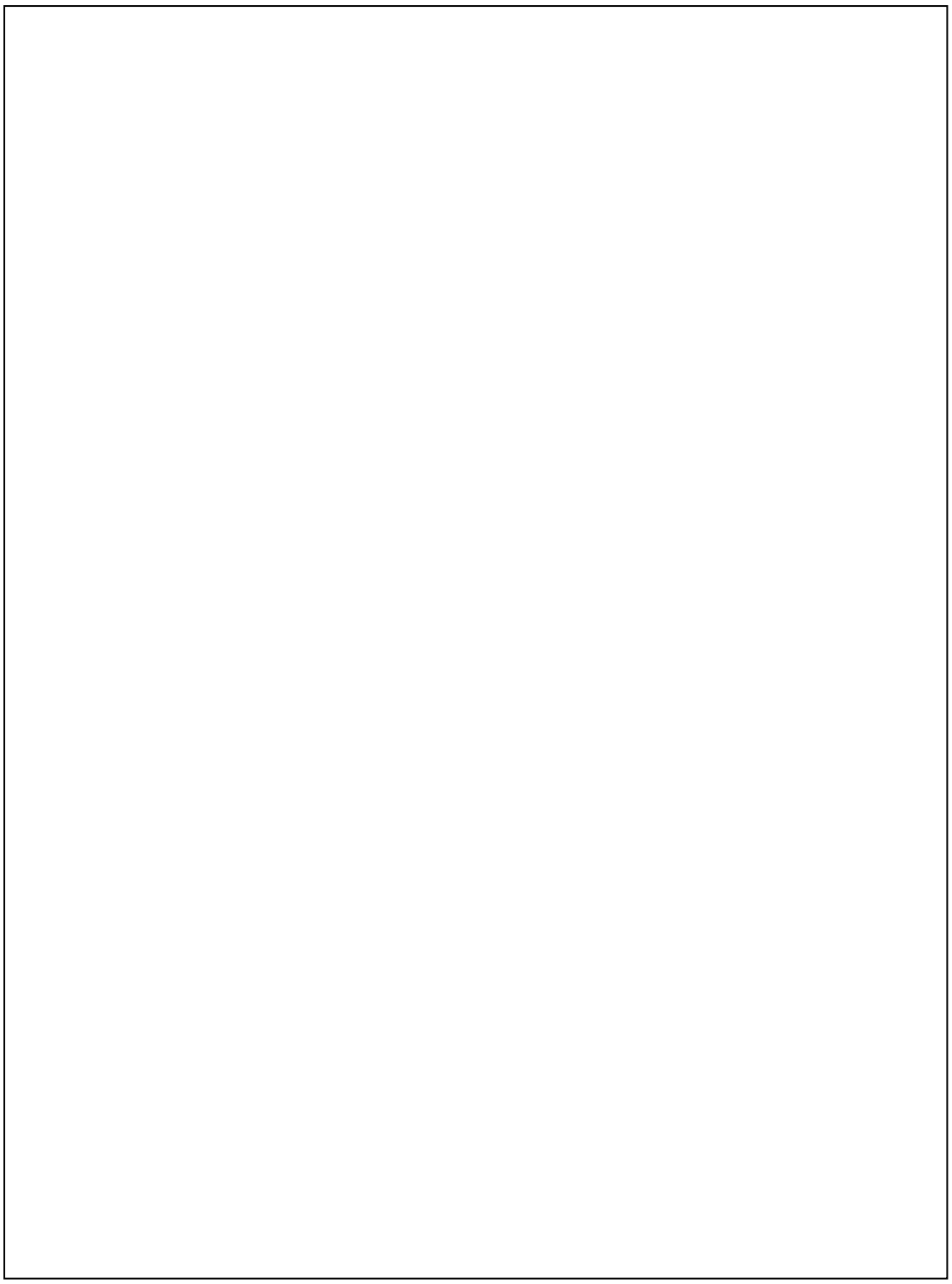
- Record any observations that you make throughout your investigation. Also include anything that may have gone wrong, or not worked as you had planned.



Problem Solves

Discussion

- Draw a picture of your “Action-Reaction Rocket”. Label the action and reaction forces.
- Are the action and reaction forces equal, less than or greater than each other?



- How does the balloon size relate to the action and reaction forces?

- Graph the results with the size of the balloon on the x-axis and the distance travelled on the y-axis.

Conclusion

State if your results support Newton's laws of motion and summarize your findings from the experiment.

References

- Figure 1 https://www.flickr.com/photos/nasahqphoto/6012071553/in/photolist-r8D1Wj-dSzo2A-hG4EHb-o4T16c-U6SM7x-hxEG1Y-RDSvmS-RL3vhk-6yQzQ4-nLEpPS-aagrq6-rokQXY-WeRa56-aagrkv-r9Xj47-rzAoQ8-SHUWEn-hxFcGQ-U34w9D-rFxigT-fJUfWd-SNzaYZ-fKURhz-dRbXqs-U34w48-5dbG6n-anGs24-SNz6Sc-WxxcPb-onH7eK-ed9XJo-UFJAi6-91kU8-ed4pX2-nGmWvB-UXLwdT-cEQdcG-ckE7N1-6gL3mB-hxErKn-cy4W3y-eZpj4B-TsfJGm-d3kv13-m2SWHp-fvaPDU-jZnc1n-e9PVzw-JqF4Vd-aajeLd/ Author NASA HQ PHOTO Licence https://creativecommons.org/licenses/by-nc-nd/2.0/
- Figure 2 Author Nabil George for ASELL.