Printing Rockets

OVERVIEW

In this project, students design and print a rocket which is then launched using an easily created launcher.

GRADE LEVELS

Based on the depth and the additional pieces that the teacher may wish to include, this project would be suitable for upper middle school students. (12 – 14 years old) as well as highschool physics students.

STEPS TO COMPLETION

1. Students are introduced to the science of rocketry and are asked to research ideas of aerodynamics and changing designs of rockets over the past several decades.
2. Students could be asked to share their research in a number of ways (classroom discussion, presentation, etc)
3. Next, students are asked to use 3D design software (Tinkercad, Google Sketchup, etc) to design the nose cone and tail fins for a rocket.
4. To shorten the print time: Have students only design nose cones and fins. Use thin pvc pipe for rocket bodies and attach with glue/tape. This shortens the print time necessary for full rockets and results in significantly easier prints.
5. 4) Your full rocket design should have a hole that is 1-inch in diameter and deep enough to place on a stomp rocket launch platform. Your “cone” and “fin” designs should have attachment points for inserting into a 1-inch diameter PVC body.
6. In designing the rockets, students can test a variety of features. Perhaps trying out different nose sizes and shapes. They can alter fin sizes, shapes and numbers. They also need to keep in mind the total weight of the rocket. It needs to

be heavy enough to fight air resistance (i.e. if its as light as paper, it will just flutter in the wind!), but it can't be so heavy that it simply drops like a rock!

7. After research, discussion and revision of their original designs, students will print out their physical rockets.

At this point, depending on the age of the students that this activity is being completed with, the activity could end, or else it may continue with a number of activities centering around the physics involved.

1. You will be studying IMPULSE using stomp rockets. The basic theory behind the stomp rocket is to apply a force to a bottle. This force pushes air through some pipes and the impact of the force of this air with your rocket causes it to launch. Your impulse could be measured by finding just a few simple quantities (i.e. the force exerted, the time that force acts, the initial momentum, the final momentum right after launch, etc.). Your goal in this experiment is the FIND THE IMPULSE DELIVERED TO A STOMP ROCKET.
2. A.) What is the theoretical angle to launch your rocket and obtain maximum range?
3. B.) How does the stomp rocket operate using the principles of momentum/impulse?
4. C.) If you jump on the bottle, you are exerting a force equal to your mass multiplied by the acceleration due to gravity. Calculate this force. Is this a reasonable force to use as an estimate of the force delivered through your rocket launching platform? Why/why not?
5. D.) Find a way to measure the impulse that is delivered from your bottle to your rocket. You can use any equipment that you can find in the lab. Once you think you have an approach, ask your instructor and they will approve you to conduct multiple trials to get a good estimate of your delivered impulse. (hint: recall Newton's original description of his second law, Force = dp/dt)
6. E.) Take your launch platform, rocket, a meter stick and a video camera (a smartphone will work wonderfully!).
7. F.) Setup your camera so that the recording plane is parallel with the intended path of your rocket. Make sure that your meter stick is clearly visible within the video frame (you will need it for calibration) and that your rocket's entire trajectory is caught on video.
8. G.) Now its time to launch your rocket! You must find a way to determine how well your theory matches your observations based on the velocity that your rocket leaves the launcher with (you must find a way to measure this velocity. (Instructions for using Tracker software can be found in the downloadable lesson plan document below)

<u>FOLLOW UP</u>

Students could follow up this research on rockets with looking at the impact of aerodynamics on other design fields (aircraft, automobile, etc)

EXTENSION QUESTIONS

1. What are other similar topics that could be studied using the same method that you designed for this project?
2. What other tools could you use for this project that you didn't have access to that would have been helpful?
3. What are variables that need to be controlled for in this project? How did you control them? Are you satisfied with that control?

This project was originally created by:

Eric Bubar
ebubar@marymount.edu