Mighty Seltzer Rocket

RKT-555

Some background:

Newton's Three Laws of Motion are essential to rocket science. Our Mighty Seltzer Rocket's propulsion is caused by the interaction of water and an Alka-Seltzer tablet. The thrust for the rocket is the production of carbon dioxide pushed out of the rocket's base. In addition, a demonstration of the transfer of energy, and an example of the conservation of energy is present in the experiments. The stable design allows students to explore variables for fuel and flight investigations.

How does it work?

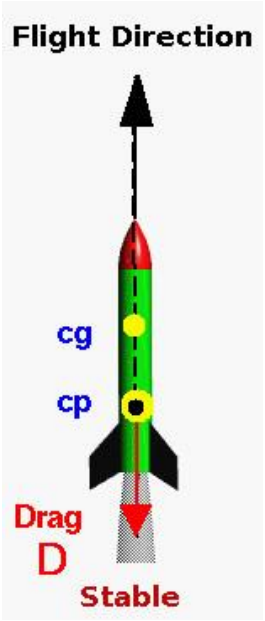
This really *is* rocket science! Students will conduct trials launching the Mighty Seltzer Rocket in the safety of the classroom. Among other things, they will learn that the stability of a rocket in flight is paramount.

The **Center of Pressure** (CP) is the point at which the aerodynamic forces on a rocket in flight are centered. However, the Center of Pressure should not be confused with **Center of Gravity** (CG).

CG is the center of the mass or weight of the rocket. For a rocket to be stable, the CP must be behind the CG. The Seltzer Rocket is designed in such a manner; the design gives it a straight and true flight.

When a rocket is in flight, four forces act on it: **weight**, **thrust**, **lift** and **drag**.

1. The amount of **weight** depends on the mass of all the parts of the rocket and gravity.
2. The rocket's propulsion system causes **thrust**.
3. **Lift** is not as significant a force on a rocket as it is on an airplane.
4. **Drag** is the aerodynamic force that works against the movement of a rocket caused by the friction of the air.



A stable rocket has its center of pressure (cp) behind the center of gravity (cg).

Image Credit: NASA

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Get to Know
Newton's Three Laws of Motion

Newton's First Law of Motion states that an object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

How does it relate to rocket science? *A rocket will stay on the launch pad until a force blasts it off. Once in space, a rocket will continue to move unless retrorockets are fired to slow the rocket down.*

Newton's Second Law of Motion states that acceleration is produced when a force acts on a mass. The greater the mass (of the object being accelerated), the greater the amount of force needed (to accelerate the object). This is also expressed using the equation F = ma.

How does it relate to rocket science? *The main forces acting on a rocket in flight are the weight of the rocket, the thrust of the rocket engines, and drag as the rocket moves through the air. At any time, the sum of these forces is equal to the current mass of the rocket times the current acceleration of the rocket, or F=ma. We say "current mass" because as a rocket burns off its fuel, the mass of the rocket will decrease.*

Newton's Third Law of Motion states that for every action force there is an equal and opposite reaction force. This law is also known as "the law of action and reaction."

How does it relate to rocket science? *A rocket can lift off from a launch pad only when it expels gas from its engine. The rocket pushes against the gas, and the gas in turn pushes against the rocket. Thrust is the force that causes the rocket to lift. In space, rocket engines are usually called "reaction engines" because the law of reaction causes the spacecraft to move in a direction opposite to the direction of the engine's thrust plume, which is the expanding gas coming from the back of the rocket.*

Experimenting with the Mighty Seltzer Rocket

The Mighty Seltzer Rocket can be used in many classroom labs or demonstrations for students of all ages and abilities. For instance:

OPTION 1:
3-2-1-Blast Off! Demonstration

The Mighty Seltzer Rocket flies using the action-reaction principles of Newton's Third Law of Motion: **For every action there is an equal and opposite reaction**. This can be demonstrated easily in the classroom by using a plastic storage box to catch the fuel fall out. Pour the designated amount of water into the rocket (using the measurements on the clear rocket body), then insert half an Alka-Seltzer tablet onto the platform in the rocket body. Push the stopper in firmly. Invert the rocket, place it into the plastic shoe box, and wait for lift off.

Guiding question for this lab:

What makes this Mighty Seltzer Rocket fly?

OPTION 2:
Say It Like Newton?

After students have experimented with the Mighty Seltzer Rocket, have them draw the rocket in the phases of flight. Help them to label the pre-launch, launch, flight, apex, and recovery. Ask students, "How would Sir Isaac Newton explain this rocket based on his Laws of Motion?" For younger learners, you may want to spend time helping them with interpretation. Have them label their diagram with Newton's Laws of Motion.

After completing their diagrams, students in middle and upper grades can collaboratively create a chart as a class. They should fill in the laws and the observations that support the laws.

Newton's Laws	Brief Description of the Law	What did you observe in the pre-launch, launch, flight, and recovery of the Mighty Seltzer Rocket that supports this law?
First Law		
Second Law		
Third Law		

Guiding question for this lab:

How do Newton's Laws of Motion govern the flight of the Mighty Seltzer Rocket?

OPTION 3: Fuel, Duration, and Flight Apex

Students can investigate how different volumes of water and amounts of Alka-Seltzer affect their rocket's motion and height flown. Remind students of Newton's Third Law of Motion: **For every action there is an equal and opposite reaction**. Can students prove this by changing certain variables?

During the lab, have students make predictions as to how much water they should add with half of an Alka-Seltzer tablet. Show the markings along the body of the rocket so they can visualize how high the water will be. (We suggest starting with 10 or 15 ml).

For younger students, you can get away with qualitative observations to determine the next prediction. For middle and upper grades, adding quantitative data (such a timing the flight or placing a measuring tape along the wall) will enhance the evidence-based learning and future predictions.

Eye protection should be worn.

Guiding question for this lab:
How does the amount of fuel in a Mighty Seltzer Rocket affect the path, height, and duration of flight?

Instruct students not to eat Alka-Seltzer.

Watch our YouTube to see the Mighty Seltzer Rocket in action!

https://youtu.be/iL3CiGNY12k

Fuel, Duration and Flight Apex Lab

GUIDING QUESTION FOR PREDICTION:

How does the amount of fuel in the Mighty Seltzer Rocket affect the path, height, and duration of flight?

My prediction is: _____

_____

MATERIALS:

1 Mighty Seltzer Rocket per team
Water
Alka-Seltzer tablets
Timer
Plastic shoe box

PROCEDURE:

1. Divide into groups of three. Each person will have a key responsibility for the lab. Agree upon which team member will perform which tasks:

    - Rocket Filler / Launch Specialist
    - Timer / Data Specialist
    - Rocket Spotter / Recovery Specialist

2. Gather materials and get ready to go to the launch site. When at the launch site, listen for instructions, stay with your group and follow all school safety rules.

AT THE LAUNCH SITE

3. The **launch specialist** inserts the designated amount of water into the rocket through the base. (Use the measurements on the rocket body to measure water accurately.) Also insert the Alka-Seltzer onto the platform in the rocket body.

4. Gently insert the stopper, pushing it in firmly. (This can also become a variable.)

5. When you're ready to launch, move the rocket (still upside down) over the plastic shoe box. Count down "5, 4, 3, 2, 1... ignition!" Then invert the rocket and place it in the box. The **timer/data specialist** should start the timer at the "ignition" command.

Fuel, Duration and Flight Apex Lab
(continued)

6. The **spotter/recovery specialist** carefully follows the rocket and yells "Touch Down" when it lands on the ground.

7. The **timer/data specialist** halts the timer when Touch Down occurs.

8. The **spotter/recovery specialist** brings the rocket back to the team.

9. Data is recorded on the data sheet on the next page. The team can discuss the movement of each launch and record qualitative data with pictures or brief descriptions in the trajectory box on the Fuel, Duration and Flight Apex Lab data sheet.

10. Repeat step 3-9 two more times, so you have a total of three flights for the different fuel amounts.

12. Calculate the average time for each fuel amount.

13. Graph the data on a bar graph. Complete the Data Analysis and Conclusion on the next page.

Challenging advanced students with safe rocket experimentation

Using Newton's Second Law of Motion to guide them, advanced students can do mathematical calculations to predict and test the optimal conditions or proportions of water and Alka-Seltzer.

The maximum height can be determined by students gathering the angle when the rocket is at its apex and using Pythagorean Theorem and Trigonometric ratios. Your students will have a chance to solve real rocket science problems.

Conducting these high-power experiments are best done outside in an open field.

Fuel, Duration and Flight Apex Lab
(continued)

Data Collection:

1. Fill in the time from each of your flights in the Data Table.

Amount of Water & Alka-Seltzer	Trial 1 Time	Trial 2 Time	Trial 3 Time	Average Time	Trajectory of Rocket

2. Make a bar graph comparing the average amount of time the rocket was airborne to the amount of water fuel in the Mighty Seltzer Rocket.

Time Aloft

Amount of Water

Data Analysis:

3. On the back of this page, describe how the amount of water fuel in the rocket affected the amount of time it was airborne.

4. Draw a picture of the Mighty Seltzer Rocket in flight. Use arrows to show the action and reaction forces that caused the rocket to fly.

Conclusion:

5. On the back of this page, describe how the science of the Mighty Seltzer Rocket's flight is similar to a "real rocket."

6. On the back of this page, describe a real life experience where you saw the action and reaction forces in action.

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Dropper Popper (POP-100)

Dropper Poppers are more than just half of a rubber ball. This incredible device seemingly defies the laws of physics by bouncing higher than where you dropped it! Requires a small amount of 'activation energy' to work. It is molded into a very special shape that allows it to store elastic potential energy and then convert it to kinetic energy with a POP when dropped from a low height. Dropper Poppers make a great 'activation energy' demonstration. An engaging activity for any Physics or Chemistry class!

Rocket Balloons (RKT-135)

A great way to demonstrate the basic principles of Newton's Laws to students. In order for a rocket to be stable, the center of gravity must be forward of the center of pressure. Balloons are inherently unstable which is why they swirl around in every direction when you allow the air to escape. Rocket balloons are properly weighted to create stability.

Reaction Rocket (RKT-625)

Appearances can be deceiving. This rubber ball launcher and foam rocket may look simple, but they're a sure-fire way to provoke a WOW reaction—and introduce students to Newton's Laws. Hold the launcher by its straw and drop straight down onto a hard surface. The rocket shoots up dramatically higher than its original drop height. Explaining energy conversion was never this easy... or this much fun! Comes with one launcher, two rockets. Class Kit includes 15 launchers and 40 rockets.