

## Civil Air Patrol's

### "Fizzy Rocket"

For Use As Enrichment After CAP Foam Rocket  
by AAS/SW Joint National Project: STEM Outreach



#### Partners in Aerospace and STEM Education:



Arnold Air Society



Civil Air Patrol



United States Air Force



Air Force Association



Silver Wings

**Topics:** rockets, Newton's laws of motion, matter (science, math)

**Length of Lesson:** 45-60 minutes, or as long as is desired, using as much of this lesson as is needed

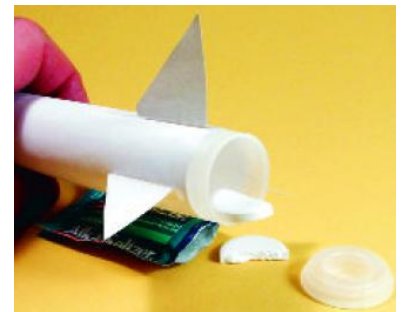
**Lesson Reference:** <http://spaceplace.jpl.nasa.gov/en/kids/rocket.shtml>  
[http://www.fmalive.com/\\_downloads/fizzy20070511.pdf](http://www.fmalive.com/_downloads/fizzy20070511.pdf)

#### National Science Standards:

- Content Standard B: Physical Science
  - Position and motion of objects
- Content Standard E: Science and Technology
  - Abilities of technological design
  - Understanding about science and technology

#### Objectives:

- Students will construct and launch a rocket.
- Students will explain and apply Newton's laws of motion.
- Students will identify a solid, liquid, and gas.
- Students will demonstrate a chemical reaction.



#### Background Information:

The lesson, which demonstrates rocketry and Newton's laws of motion, will take longer than thirty minutes if each step is followed. If time is an issue, you do NOT need to have students make the film canister look like a rocket. You may skip step 4 in this lesson plan. If this is your plan, have the film canisters already filled about 1/3 full of water. Distribute the prepared film canisters to students along with an effervescent tablet to use with either the "Fizzy Rocket Data Sheet" or "Fizzy Rocket Experiment Form."

## Materials:

- plastic 35 mm film canisters (keep and reuse over and over)  
The film canister must have an internal-sealing lid, like many Fuji and translucent canisters. The canister **MUST** have a cap that snaps **INSIDE** the rim instead of over the outside of the rim. Photo shops and labs will be happy to save and donate some for educational purposes; however, these types of canisters are becoming difficult to find.  
They are available for purchase at the following online sites:  
<http://www.teachersource.com/Energy/EnergyConversion/RocketFilmCanisters.aspx>  
<http://www.sciencebobstore.com/products.php?product=Bulk-Film-Canisters-for-Rockets>  
<http://www.stevespanglerscience.com/product/flying-film-canisters>
- effervescent antacid tablet, such as Alka Seltzer
- paper (copy paper or construction paper) - tape
- Fizzy Rocket Data Sheet **OR** Fizzy Rocket Experiment Form
- scissors
- paper towels
- water
- bucket or pitcher
- eye protection
- index cards (for fins)

**NOTE:** It is suggested that you allow students to work in pairs or groups of three for this activity. Determine what is appropriate for the students in your classroom. Also, determine which Fizzy Rocket data sheet you will use for this activity. (See step 8 below for more info.)

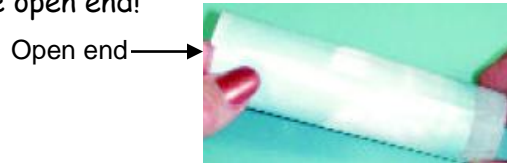
Consider watching the video available at

<http://www.stevespanglerscience.com/product/flying-film-canisters>. Unlike examples in the video, this lesson plan asks the participants to flip the canister upside down after sealing the lid.

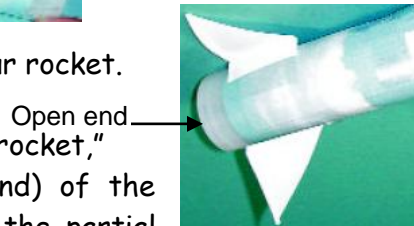
## Lesson Presentation:

1. Show a film canister and ask students to record ideas on how to make it fly.
2. Discuss student ideas. Remind students that according to Newton's third law of motion, there must be some action to result in a reaction. Also, tell them that Newton's first law of motion says that an object at rest will stay at rest unless there is some force that disrupts its rest. The opposite is also true. An object in motion will remain in motion unless there is some other force or forces that cause it to stop its motion. For example, a kickball on the ground stays there resting until a force causes it to move. Ask students what would cause the kickball to move. (the force of the moving leg that strikes it) Ask students what force(s) will cause the kickball to, if it flies up, come back down and stop moving. (gravity and friction, if they have studied friction) Tell students that they should remember these concepts as they prepare a film canister to rocket upwards away from Earth.
3. Distribute a canister for each student (or group of students).
4. Distribute materials (paper, scissors, index cards, Fizzy Rocket Template, tape) to make the canister look like rocket. If time is an issue, you may omit this step.

- Remove the lid from the film canister and put it in a safe spot so it will not get lost.
- Cut out the body tube template for the rocket.
- Wrap and **tape** the body tube of paper around the film canister without covering the open end!



- Using the template, cut and tape fins to your rocket.
- Construct a nosecone for the top of the "rocket," and tape the cone to the top (closed end) of the canister. To create a nosecone, cut out the partial circle in the fizzy rocket template. Overlap and twist the open ends of the circle to create a cone. Tape and cut as needed.
- Have students clean their work area.



5. It is EXTREMELY important to demonstrate how to correctly put the lid on the film canister. Tell students they should hear a "snap" sound. If they do not hear a "snap" sound when putting the lid on the canister, the lid is not on, and the canister will NOT launch correctly. With students seated, have each student or pair of students practice snapping the lid on and off of the canister. It is very important to have the lid on correctly for the rocket to launch.
6. While students are practicing correctly opening and closing the canister, make sure you have a bucket or pitcher of water. If you are doing this demonstration activity indoors, lay out a garbage bag or some type of drop cloth for a launch pad.
7. Demonstrate how the students will launch their rocket. Put on eye protection. Fill the film canister about 1/3 full of water (or about 10 ml). (You may choose to have students use a graduated cylinder to measure water, or you may have a plastic cup marked with the correct amount of water to pour into the canister. If students are measuring amounts of water used during the experiment, it is easy for them to see and test water as a variable for launching the fizzy rockets - if time allows for additional experimentation.) Place the half-sized seltzer tablet into the canister and quickly snap the lid shut. Quickly place the canister with "snap" side down on the launch pad. (The top has to be put on quickly to be able to produce the desired pressure inside the canister. The canister has to be placed quickly in its position for launch, as well.) Count how many seconds it takes for the rocket to launch and how many seconds the rocket stays in the air before hitting the ground. Record the times on the board.

8. Distribute either the "Fizzy Rocket Launch Data Sheet" or the "Fizzy Rocket Experiment Form," depending on which you prefer for your students. Use the "Fizzy Rocket Experiment Form" if students are using a combination of  $\frac{1}{4}$ ,  $\frac{1}{2}$ , and whole tablets. Go over the directions for the sheet that you have selected for your class.
9. If not already outside, go outside to launch the students' rockets. Prior to launch, if students are in groups of three, they should rotate among the following tasks for each launch: (1) set up the canister to launch (2) count how many seconds it takes to launch after the rocket is placed in launch position (3) count how many seconds the rocket stays in the air before it hits the ground. The students should record the times on their data sheet.
10. Prior to the first launch, ask a volunteer to explain the steps they will follow to launch the rockets. (Put on eye goggles. Fill the canister about  $\frac{1}{3}$  full of water (or 10 ml). Put the tablet in. Make sure the lid snaps on. Place the canister in launch position. Count to see how many seconds it takes to launch and how many seconds it stays in the air. Record the results of both counts.)
11. Distribute the effervescent tablets. Use the water to fill canisters and allow the students to conduct their launches.
12. Once the students have launched the rockets and completed their information, have students clean up the area and assemble together in the classroom. If the "Fizzy Rocket Launch Data Sheet" was used, allow students time to figure out the average launch and flight times.
13. Discuss how Newton's three laws of motion were at work in this activity.
  - Law #1 (Inertia): The rocket is at rest until it lifts off due to a force acting upon it. That force is the pressure that has built up inside the canister and escaped.
  - Law #2 ( $F=ma$ ): The amount of force created is directly proportional to the mass and acceleration of the water and gas expelled from the canister.
  - Law #3 (Action/Reaction): The top is forced off the canister due to the pressure produced by the fizzy gas. That fizzy gas is actually carbon dioxide. Ask students if they know what caused that gas to occur. The carbon dioxide is a result of the chemical reaction that took place when the fizzy tablet was added to the water. A result of the chemical reaction is the accumulating pressure due to the buildup of gas inside the canister. The pressure of the carbon dioxide bubbles builds up so much that it finds the weakest structural point in the canister through which to escape. The weakest structural point is the area where the lid snaps onto the canister.

The action of the high pressure escaping out of the canister causes the opposite reaction of the canister being propelled into the air.

14. Allow students to discuss the results of their data sheet and what they feel they have learned from the experiment.

**Summarization:**

Ask students what might account for some differences in the number of seconds to launch and land. (Some students may have counted faster or slower. Some students may have had a little bit more or less water in their canister. Some students may have had a little bit more or less of the effervescent tablet. Part of the tablet may have been protruding out from the water when the canister was placed in launch position.)

Ask students to identify the liquid in their experiment. (water) Ask students to identify the solids in the experiment. (canister, tablet) Ask students to explain what created the gas in their experiment. (a chemical reaction: the tablet reacting in the water produced gas bubbles) Ask the students to explain what made the rocket canister "explode" and allow the rocket to launch. (Newton's Three laws of motion)

A great explanation from <http://spaceplace.jpl.nasa.gov/en/kids/rocket.shtml>:

*When the fizzy tablet is placed in water, many little bubbles of gas escape. The bubbles go up, instead of down, because they weigh less than water. When the bubbles get to the surface of the water, they break open. All that gas that has escaped from the bubbles pushes on the sides of the canister.*

*When you blow up a balloon, the air makes the balloon stretch bigger and bigger. But the little film canister doesn't stretch and all this gas has to go somewhere!*

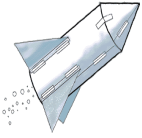
*Eventually, something has to give! So the canister pops its top (which is really its bottom, since it's upside down). All the water and gas rush down and out, pushing the canister up and up, along with the rocket attached to it.*

*Real rockets work kind of the same way. But instead of using tablets that fizz in water, they use rocket fuel. The **action** is the gas rushing out of the rocket. The **reaction** is the rocket taking off in the other direction. In other words, for every action there is an equal and opposite reaction. The rocket goes in the opposite direction from the gas, and the faster the gas leaves the rocket, the faster the rocket gets pushed the other way.*

Character Connection: Tell students that the fizzy rocket should remind us of something we do not want to do in life: "pop-off." Sometimes, we feel ourselves getting very upset. It feels like the pressure building up inside that small canister and builds until we want to explode. We are not rockets. We must find other ways to deal with bad pressure. Have students name ways they can prevent "popping their lid." When we find alternative ways to handle frustration and anger, we gain control in our lives. We become our own directional fins able to travel steadily through life.

### Assessment:

- leader observation
- constructed rocket
- data sheet
- student answers to class discussion questions
- "Fizzy Rocket Reflections" worksheet (optional)



### Additional activity ideas to enrich and extend the primary lesson (optional):

- Have students complete the "Fizzy Rocket Reflection" worksheet. **Answers:**  
1) water 2) tablet 3) pressure, gas, or chemical reaction 4&5) answers will vary  
Bonus: chemical reaction
- Find the mean, median, and mode of a list of launch times and flight times.
- Experiment with the launch performance of canisters with and without fins and with and without nosecones. Real rockets have nosecones to reduce drag, and they have fins to create stability.
- Write an expository paragraph explaining how to make a film canister fly.
- Conduct the **Water Bottle Rocket Launch** enrichment activity that follows all Fizzy Rocket documents.
- Help students gain a better understanding and an appreciation for rockets that deliver payload (e.g., satellite, rover, humans) by having them participate in this **"Rocket to Mars" design challenge.**

Room set up: Place three 50 cm circles (Mars - destination) in three separate places with masking tape on the floor. Place a line of tape (Earth - launch site) 3 meters from each circle. Have extra balloons on hand as students re-launch their rockets!

Materials per team of 3 students: 1 toilet paper tube, 1 drinking straw, 1 wooden skewer (with ends cut off or blunted), 1 balloon, 1 ping pong ball

- Additional materials available to all: construction paper, aluminum foil, and a variety of tape (duct tape, scotch tape, masking tape, etc.)

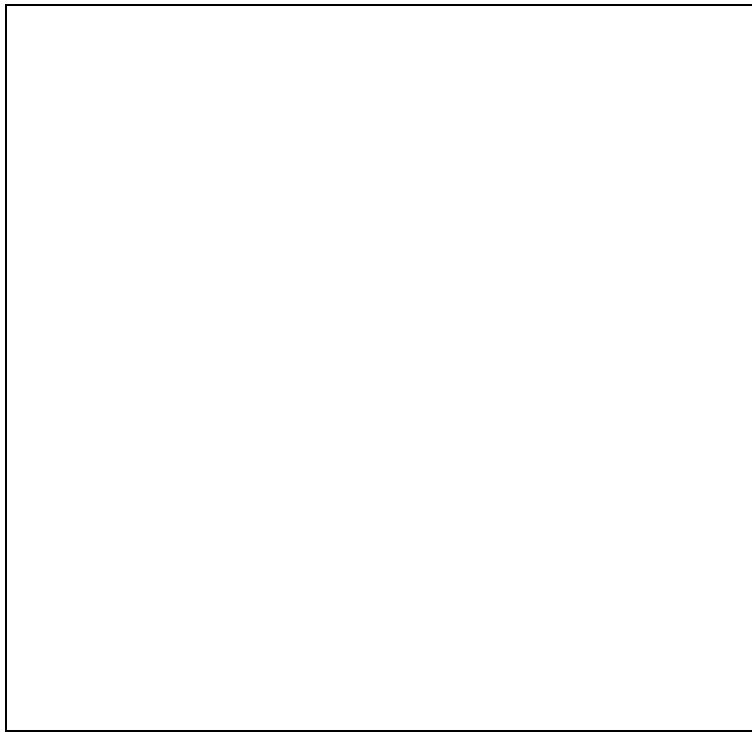
### Instructions:

1. Explain/demonstrate the difficulty of hitting a moving target. Lead into challenges of launching a spacecraft or satellite from a moving Earth to land on another moving target, such as the International Space Station (ISS) or Mars.
2. Explain the design challenge to the students: Each team must use the items to create a rocket that can deliver the ping pong ball (the payload) to Mars (represented by the circles on the floor) from Earth (tape lines). To make things easier, the targets are not moving. The teams have 50 minutes to design and

test their vehicles. If they are unsuccessful, they may make modifications and try again (waiting their turn at one of the 3 stations). The "propulsion system" for their rocket is the balloon. Each team will slide its straw over the skewer to create a "launch pad" that can be adjusted to the team's desired angle of launch by the person holding the skewer. The straw should be secured to the team's rocket design. To succeed, the rocket must land in the circle, not slide into it. Teams who succeed may make additional modifications to try to reach a target that is farther away.

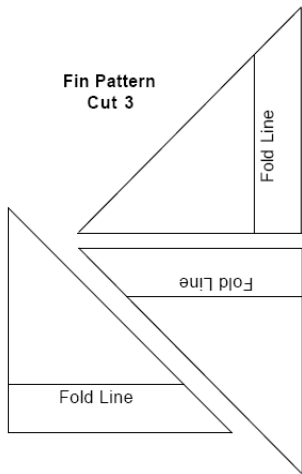
Closing: This is a real challenge, and few teams will succeed. Emphasize that the students were trying to land a rocket and its payload onto a non-moving target. Mars, Earth, and the International Space Station are all in motion, which means designing is even more challenging! Students probably came to the realization that weight was a factor in their launch vehicle. Rockets that were the simplest (no extra decorations and lightest weight tape) traveled the farthest.

# Fizzy Rocket Template

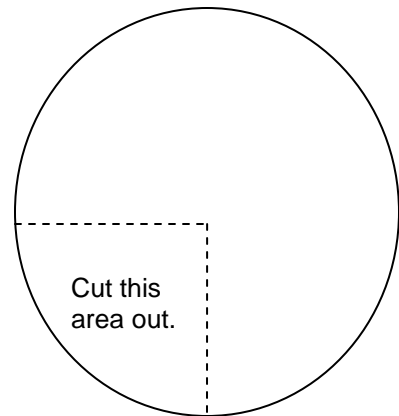


← for body tube

Cut out the square. Use tape to attach one edge to the canister. Wrap the paper around the canister, and tape it to hold it in place. (Trim paper as needed)



Use index cards for fins



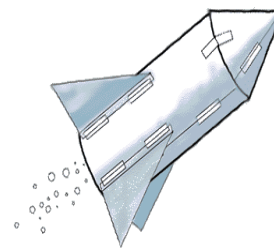
Cut out to make nosecone.







# Fizzy Rocket Launch Data Sheet



Name(s): \_\_\_\_\_

What size tablet are you using for your 3 launches? \_\_\_\_\_

Fizzy Rocket Launches	Launch 1	Launch 2	Launch 3	<b>Average</b> Add all three launch times and divide by 3; Add all three flight times and divide by 3.
<b>Launch Time</b> (in seconds) from the time the canister is placed in launch position to launch				
<b>Flight Time</b> (in seconds) time in the air from launch to landing				

Enrichment: If your teacher has extra supplies and time, try additional launch experiments and complete the following chart, or obtain your own film canister and try this at home. Remember to wear eye protection!

Fizzy Rocket Launches	Draw and indicate size of tablet. ( $\frac{1}{4}$ , $\frac{1}{2}$ , etc.)	How much water?	Launch Time (in seconds) from the time the canister is placed in launch position to launch	Flight Time (in seconds) time in the air from launch to landing
Launch 1				
Launch 2				
Launch 3				

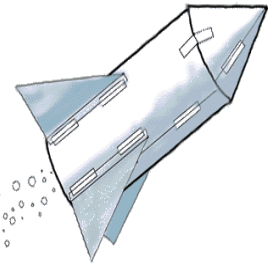
What can you conclude from your experiments? (Use the back of this paper if you need more room to answer.)

NAMES: \_\_\_\_\_

Tablet Size	Launch Time (in seconds)	Flight Time (in seconds)
$\frac{1}{4}$ tablet (quarter)	_____ seconds	_____ seconds
$\frac{1}{2}$ tablet (half)	_____ seconds	_____ seconds
1 tablet (whole)	_____ seconds	_____ seconds



## Fizzy Rocket Experiment Form



- Which tablet size launched the fastest?  
\_\_\_\_\_
- Which tablet size took the most time to launch?  
\_\_\_\_\_
- Which tablet size stayed in the air the longest?  
\_\_\_\_\_
- Why do you think the tablet that launched in the

shortest amount of time (fewest seconds to launch) did so?

5) Were you surprised by any of the results? If so, name something that surprised you and try to explain why you think this "surprise" result occurred.

6) What do you feel you have learned from this activity? (Use the back of this paper to answer if you need more room.)

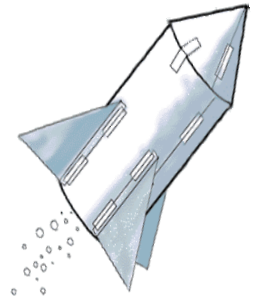
### ENRICHMENT: Conduct your own experiments!

Tablet Size	Amount of Water	Launch Time (in seconds)	Flight Time (in seconds)
		_____ seconds	_____ seconds
		_____ seconds	_____ seconds
		_____ seconds	_____ seconds

What do you feel you learned from your experiments?



## FIZZY ROCKET REFLECTION



NAME \_\_\_\_\_

1. Name the liquid that was used in your fizzy rocket experiment. \_\_\_\_\_

2. What was the solid fuel that was used during your fizzy rocket experiment?

\_\_\_\_\_

3. What was produced when the tablet was added to the water? \_\_\_\_\_

4. Explain one of Newton's three laws of motion.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. Explain why the canister launched into the air. (Your answer must include more than just "Newton's 3<sup>rd</sup> Law of Motion.") Use the back of this paper if you need more room.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**BONUS:** What type of change caused the gas to form inside the canister?

\_\_\_\_\_

## Rocket Enrichment Activity: Water Bottle Rocket Launching

### Materials:

empty 2- liter bottle  
cork to insert into bottle opening  
bicycle pump and inflator needle  
3-4 small dowels, rods, or sticks (with optional wooden base and nails to attach)  
cardboard  
duct tape  
clay or other material(s) for making nose cone (optional)  
straw (optional)  
colored permanent markers and/or stickers for decorating bottle rocket  
bucket of water  
eye goggles

1. Get an empty 2-liter plastic bottle.
2. Make 3 or 4 cardboard fins to attach to the bottom of the bottle to make a bottle rocket. Use duct tape to attach. (Note: Ensure that the fins are pointed in the direction in the photo as the opening of the bottle will be the bottom of the rocket.) Students should experiment with the height of the fins to get the most stability.
3. Decorate the bottle rocket as desired with markers or stickers.
4. If desired, add some weight to the top of the rocket by adding some clay or other material covered with duct tape to make a nose cone. Experiment with various top weights and fin positions in order to get the most accurate center of mass (or center of gravity) to balance the rocket for best launch control.
5. Insert a cork into the opening of the bottle. (If the cork does not fit well, microwave the cork no more than 25 seconds to soften it and then put it in the opening. It will cool quickly and will fit snugly, but will be able to be pulled in and out of the opening, as needed.)
6. Insert a bicycle pump inflator needle into the center of the cork, ensuring it goes completely through to allow air to flow through the cork and into the bottle.
7. Attach the bicycle pump hose end to the needle.
8. Make a simple rocket base by using 3 or 4 dowels, sticks, or rods inserted into the ground or onto a piece of wood. The opening end of the rocket should rest near the base. OR, as in the photo, use a single rod either inserted into the ground or on a



wood base. With this plan, a straw will need to be attached to the side of the bottle rocket in which to insert the rod for launching.

9. Add varying amounts of water to the bottle rocket and close with the cork stopper. Experiment to determine which amount of water works best to make the rocket launch highest. (A lot or a little?)
10. Youth should wear eye goggles before starting to pump air into the bottle rocket and should not lean directly over the bottle. **No goggles here! ☹ →** Safety should be foremost in this activity!
11. It is best to angle the bottle a bit away from the person doing the launching, ensuring there is a clear opening 30-60 feet forward and high to allow the bottle rocket to launch. With older students, the angle of attack can be determined by wind direction and speed.
12. Pump air into the rocket. The amount of air pressure needed to launch the rocket will depend on how much water is in the bottle and how tightly the cork is inserted into the opening.
13. After several pumps, the amount of pressure will be enough to overcome the friction holding the cork in the opening thus popping the cork out of the bottle and launching the rocket into the air with a water tail following it.
14. When launching, have another person measure the height the rocket reaches with an altimeter, if so desired.
15. Discuss how Newton's three laws of motion were at work in this activity.



- Law #1 (Inertia): The bottle rocket is at rest until it lifts off due to a force acting upon it. That force is the pressure that has built up inside the bottle and escaped.
- Law #2 ( $F=ma$ ): The amount of force created is directly proportional to the mass and acceleration of the water and air expelled from the canister.
- Law #3 (Action/Reaction): The cork is forced out of the bottle due to the pressure produced by the air being pumped into the bottle. The air pressure builds up so much that it finds the weakest structural point in the bottle through which to escape. The weakest structural point is at the cork. The action of the high pressure escaping out of the bottle causes the reaction of the bottle being propelled into the air.