Film Canister Rockets- notes and risk assessment. www.sciencebob.com

# Task

To try different variables to time how long a film canister rocket takes to launch, and to measure how high it goes.

# Equipment

* One empty 35mm plastic film canister and lid. These are getting harder to find, but stores that develop film should have some. (The white canisters work much better than the black ones do.)
* One fizzing antacid tablet (such as Alka-Seltzer, or effervescent vitamin tablets - Get this from your parents) **HOMEWORK: BRING IN SOME EFFERVESCENT TABLETS SUCH AS VITAMINS, STERADENT, ALKA-SELTZER.**
* Water
* Safety goggles
* Measuring cylinder
* Stopwatch
* thermometer
* heatproof mat
* small piece of blu-tac
* paper towels (to clear up the mess)
* metre stick
* tray for containing the mess

# METHOD

1. Put on safety goggles and collect the apparatus for each group. Each group use a tray to store your materials; this will contain the mess.
2. Head outside, if it is nice weather and your teacher tells you to.
3. Measure out 5ml of water in a measuring cylinder.
4. Remove the lid from the film canister and pour the 5 ml of water into the canister.
5. Record the volume in your jotter.
6. Using the thermometer take the temperature of the water.
7. Record the temperature in your jotter.
8. Break the antacid tablet in half.
9. Using a small piece of blu-tac, stick the half a tablet to the lid of the canister.
10. Carefully snap the cap onto the canister being careful not to drop the tablet into the water. Make sure that it snaps on tightly or the rocket won’t work.
11. Quickly put the canister on the heatproof mat in the tray CAP (lid) SIDE DOWN
12. Start the stopwatch as soon as the film canister is turned.
13. STEP BACK at least 2 metres from the rocket as soon as you have turned in lid side down
14. Stop the stopwatch as the rocket launches into the air!
15. Record the time for launch and if possible try to work out a method for determining how high the rocket went.

Caution: If it does not launch, wait at least 30 second before examining the canister. Usually the cap is not on tight enough and the build up of gas leaked out.

# WHAT IS HAPPENING

There's nothing like a little rocket science to add some excitement to the day. When you add the water it starts to dissolve the alka-seltzer tablet. This creates a gas call carbon dioxide. When the lid is fitted tightly to the canister this gas is contained within an enclosed space. As more gas is given off the pressure inside the canister rises until there is enough force to overcome the seal of the lid. The built up pressure exerts enough force to shoot the canister into the air, forming the rocket. This system of thrust is how a real rocket works whether it is in outer space or here in the earth's atmosphere. Of course, real rockets use rocket fuel. You can experiment controlling the rocket's path by adding fins and a nose cone that you can make out of paper.

# ALTERING THE VARIABLES

1. Try altering variables to see how quickly you can get the rocket to fire, or can you adjust the variables to try to get the rocket to fire after say 15 seconds.
2. Think about your variables, what could you change?
3. Does water temperature affect how fast the rocket launches?
4. Does the size of the tablet piece affect how long it takes for the rocket to launch?
5. Can the flight path be controlled by adding fins or a nosecone to the canister?
6. How much water in the canister will give the highest flight?
7. How much water will give the quickest launch?

# Tips for Success

Make sure the film canister lid is tightly fitting or you will only get a disappointing 'fizz'. You should also clean the canister lip and lid between demonstrations so that no pieces of Alka-Seltzer get stuck between them, ruining the seal.

## RISK ASSESSMENT

## There are LOW LEVEL risks to this experiment and these should be discussed with pupils prior to starting the practical.

1. **Under no circumstances should the tablets be ingested.**
2. **Hands should be washed after the tablet has been handled and eyes should not be rubbed, the chemicals could cause eye irritation.**
3. **Goggles must be worn at all times.**
4. **Bags must be out of the way.**
5. **Students should be asked if they have allergies to any of the tablets, or chemicals they contain.**
6. **All spillages must be cleared up immediately, the mix at the end is very sticky and can stain.**
7. **tablets should be counted in and only one tablet give to each group at a time.**
8. **tablets can be reused.**
9. **thermometers should be alcohol in glass and not mercury thermometers.**
10. **thermometers should be carefully left somewhere safe between readings. There is a temptation to abandon them and they can be easily broken, especially if the students get excited.**
11. **It is not always possible to control the direction of travel of the rockets which is why it is important to either let one rocket off at a time or control the launch area and keep just one area a space for launching rockets.**
12. **Students must not lean directly over the rocket. The force is such that is could cause bruising, and worse if eye protection isn’t worn.**
13. **change the temperature of the water with ice from the store in water or use the warmest water from the hot tap in the room. Do not boil the water as the canisters cannot cope with water of this temperature.**

*enjoy!*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| volume of water  (ML)  ) | temperature of water  (°C) | quantity of tablet | size of pieces of tablet | time to launch  (s) | height of rocket  (m) | how much tablet is left? | comments |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

# Hypothesis

How do you think the temperature, volume of water, piece of tablet size, quantity of tablet etc. will affect the launch height and time for launch? You will need a new hypothesis for each variable. REMEMBER you must only change one variable at a time so that you can identify if it has an effect. If you change all the variables at once you will not be able to work out what is causing any change in launch time or height.

# DATA ANALYSIS

Can you plot a graph of graphs of your results to conclude any variables that consistently make a difference to the launch time or flight height?

# EXTENSION

## Did You Know?

The Chinese began building chemically powered rockets as long ago as the 1150’s. One of the great pioneers of modern rocketry, N. I. Kibaltchich was executed in 1881 after manufacturing the bomb that was used to assassinate Tsar Alexander II.

# Canister Rocket

Rockets rely on newton’s 3rd law to propel themselves into space. Newton’s 3rd law states that every force has an opposite and equal force. For example, if you push on a wall, the wall pushes back on you with the same force. Similarly, as rockets ignite and expel fuel, the engine applies a force pushing the fuel out of the rocket.

Because the rocket applies a force on the fuel, the fuel also applies the same force back onto the rocket. The force that the fuel applies to the rocket is the upward force that propels it into space. With this demo, you can make your own rocket-propelled film canister with a few household items.



**Image Credit:** steakpinball/grafixtek via flickr.

<http://physicscentral.com/experiment/physicsathome/canister-rocket.cfm>

<http://imaginationstationtoledo.org/content/2010/08/film-canister-rockets-2/>

## What is happening inside that film canister?

First of all, we all know that the most common effervescing tablet used in a film canister rocket is Alka-Seltzer. In fact, the company that makes Alka-Seltzer is so proud of the fact that it can be used in science experiments they have a whole page on their [website](http://alkaseltzer.com/as/student_experiment.html) dedicated to it! Not to rain on the Alka-Seltzer science parade but, just between us, the generic brands also work perfectly well for this activity and it saves some money.

When you mix these effervescing tablets with water, a chemical reaction takes place between the citric acid and sodium bicarbonate contained in the tablet and the water. This chemical reaction creates many, many bubbles of carbon dioxide gas. Citric acid is a weak acid and is in the juice of most citrus fruits like lemons or limes. Sodium bicarbonate is, well, basically baking soda. (Has this reminded anyone of another great science experiment that uses a weak acid and baking soda? That’s right, baking soda and vinegar [acetic acid] produce the same reaction when mixed together. Lot of bubbles of carbon dioxide gas!)

You already know what happens when you combine this chemical reaction with a film canister (it pops and goes up) but…

## Why does your rocket go up?

It goes up because gas is building and building in the closed film canister and since the lid is the weakest point of the canister, the lid pops off and all that gas comes rushing out of the end of the canister. This action can be explained using [Newton’s Laws of Motion](http://www.grc.nasa.gov/WWW/K-12/airplane/newton.html), more specifically it is an example of Newton’s Third Law of Motion – “Every action has an equal and opposite reaction”. The gas rushing out of one end of the canister (the action) causes your rocket to move in the opposite direction (the reaction). This is exactly how all rockets work whether you use an effervescing tablet as your fuel or a chemical rocket propellant like they do at NASA.

## How do the NASA rockets work?

Quite simply, rockets are how NASA can get all those amazing missions off the ground. These rockets use a pressurized fuel and an oxidizer. The oxidizer is something that allows the fuel to burn without using outside air. (Can you think of a reason why this might be important? Write your answer in the comment box below!) The fuel, in a gaseous state, is pressurized because this forces it out the end of the rocket just like our Film Canister Rocket! However, there are a few more parts to an actual rocket.

The fuel used in the rockets like the ones that help the space shuttles enter space use liquid hydrogen as the fuel and liquid oxygen as the oxidizer. You may be saying to yourself, “I thought they just said that the fuel is in the gaseous state not liquid?”. You are right, the fuel and oxidizer are only in these liquid states when they are in the holding tanks and they can only stay in this liquid state at extremely low temperatures. The fuel and oxidizer are allowed to combine within the combustion chamber and as the burn they turn into a gas (gases take up about 1,000 times more space than a liquid) this causes the intense pressure. It is exactly like our Film Canister Rocket, the carbon dioxide builds up and puts intense pressure on the canister so the lid pops off. In the case of our shuttle rocket the fuel and oxidizer burn, are put under intense pressure and are released not by the popping off of a lid but through a tiny hole on the bottom of the combustion chamber called a nozzle. If you would like to learn much more about rockets visit the [NASA](http://www.nasa.gov/worldbook/rocket_worldbook.html) website. Also, if you want to watch a mind bending video that is connected to the Film Canister Rocket activity watch [Alka-Seltzer added to Spherical Water Drop in Microgravity](http://www.youtube.com/watch?v=bgC-ocnTTto).