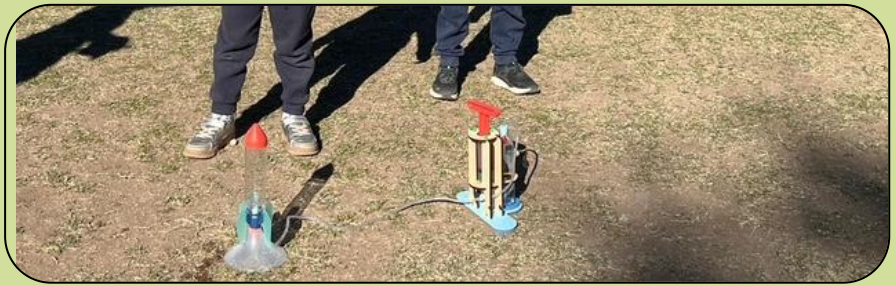
“Rocket Club ” - Designing a Better Bottle Rocket

“3... 2... 1... Blast off”



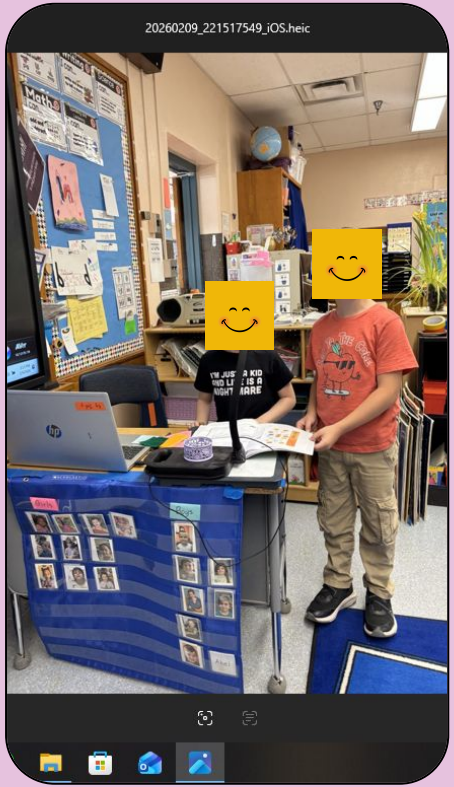
INTRODUCTION

Our project began with a student bringing in a bottle rocket he had built with a kit to show his class. He demonstrated how citric acid and baking soda reacted together when water was added to produce bubbles of carbon dioxide. The pressure of the carbon dioxide built up until it broke the seal between the rocket and the base and blasted upwards. The students went wild! Students who were interested in the rocket were invited to meet after school to investigate ways to make the rocket blast higher. Five eager kindergartners and two big brothers joined together to brainstorm ideas. These students and their innovative ideas came to be known as “Rocket Club.”

How can we make the rocket go higher?

- Pump the water twice
- Add goldfish (crackers) to the mixture
- **Add more fuel**
  - **Add an extra scoop of baking soda**
  - **Add an extra scoop of citric acid**
  - **Add vinegar instead of water to increase the acid**
  - **Increase length of tube to allow for more chemicals (fuel) to be added**
- **Use soda water instead of water (because it has bubbles)**
- Use kombucha instead of water (because it has bubbles)
- Add dye to the water
- **Use soda ash instead of baking soda**

Ideas we decided to test are **bolded.**



PREDICTIONS

Baseline Procedure

1. Water is added to a water bottle attached to the fuel chamber by a pump.
2. Water is pumped to the fuel chamber to make sure the line that connects them doesn't have air pockets. Fuel chamber is emptied.
3. One scoop of baking soda and one scoop of citric acid are added to the fuel chamber.
4. Rocket is placed over fuel chamber and pressed firmly to create a seal.
5. Camera is started so that time can be determined using slow motion video.
6. Pump is lifted and lowered to add water to the fuel chamber.

Results: Rocket is in the air for **2.1 seconds**

The OG rocket

IDEA 1

SODA ASH

Procedure and Predictions: At home, we make soda ash by heating baking soda in the oven. I think using soda ash instead of baking soda will increase the rocket's travel time. We will add two scoops of soda ash instead of the baking soda.

Results and Discussion: **Rocket does not blast off.** Later when the rocket is removed the gas causes the fuel to spray everywhere! We decide to try to double the citric acid and the rocket flies for 2.1 seconds. We will discuss why in a later slide.

IDEA 2

SUB VINEGAR

Procedure and Predictions: I think if we add two scoops of baking soda and vinegar instead of water the rocket will fly longer. This also means we only need to add two things instead of three.

Results and Discussion: **The rocket flying time increases** (3.3 seconds). We produced more carbon dioxide bubbles because we could had room to had more baking soda and the vinegar reacted in a way similar to the citric acid.

IDEA 3

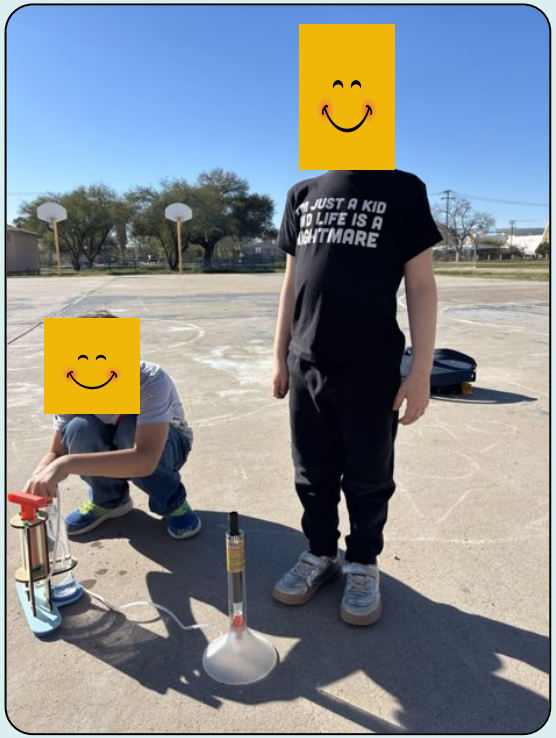
LENGTHEN TUBE

Procedure: I think by increasing the length of the tube we will be able to add more fuel and the rocket will fly for a longer. First we used duct tape to make a tube. Then we tried a rubber tube.

Results and discussion: **Duct table extender** let us add 3 scoops of each reactant, but **did not increase time of flight (2.1 seconds)**. We think this happened because the rocket hit the duct table and it slowed it down. The **rubber tube extender** allowed us to add 5 scoops of each reactant, and **increased flight time to 3.6 seconds.** More reactants mean more bubbles and more pressure so the rocket flies for a longer period!

IDEA 4

STABILIZE TUBE



Procedure: We noticed the rubber tube bended sometimes so we added a gummy bear tube to stabilize it.

Results and Discussion: The plastic tube seemed to fix the problem. Although one time the rocket flew to the side. We don't know if that happened because of the wind or because the tube bended.

IDEA 5

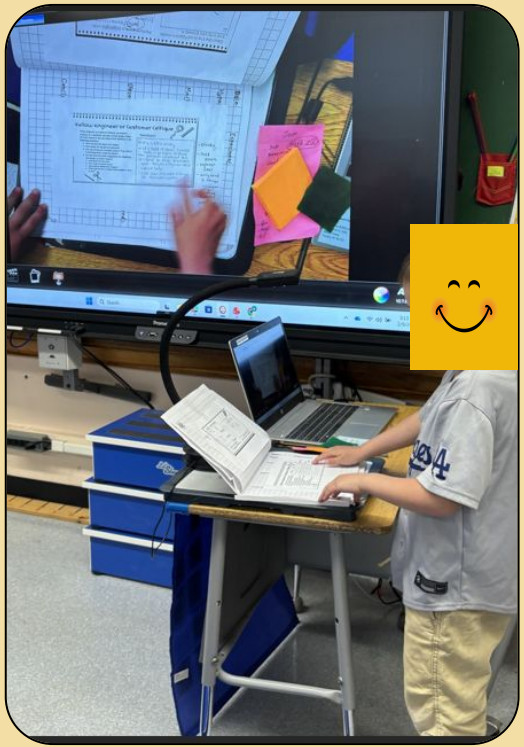
ADD SODA WATER

Procedure and Predictions: I think if we add soda water instead of water the rocket will fly for a longer period because the soda water already has bubbles in it.

Results and Discussion: **The rocket flying time increases** (2.6 seconds). It did not increase as much as the vinegar, though, so we decided to keep using the vinegar.

RESULTS

Rocket Fuel Modification	Travel Time (seconds)
Standard (1 scoop of baking soda + 1 scoop of citric acid + water)	2.1
1 scoop of soda ash + 1 scoop of citric acid + water	0 (delayed)
1 scoop of soda ash + 2 scoops of citric acid + water	2.1
1 scoop of baking soda + vinegar water (1 part vinegar to 4 parts water)	3.0
1 scoop of baking soda + 1 scoop citric acid + carbonated water	2.6
2 scoops baking soda + vinegar	3.3
3 scoops baking soda + 3 scoops citric acid + water (duct tape extender)	2.1
5 scoops baking soda + 5 scoops citric acid + water (plastic tube extender)	3.6



IDEA !

UNDERSTANDING SODA ASH

DISCUSSION

$HCO_3^- + H^+ \rightarrow H_2O + CO_2$

$CO_3^{-2} + 2H^+ \rightarrow H_2O + CO_2$

Soda ash can be made from heating baking soda to release hydrogen gas. The hydrogen represents the acid that reacts with our base (baking soda or soda ash). Since soda ash has less hydrogen we need to add more acid for the same reaction. Our results show that twice as much citric acid combined with soda ash produced the same result as combining equal amounts of baking soda and citric acid. This was not what we predicted!

WHAT WORKED

1. Extending the fuel chamber with a rubber tube so we could add extra fuel. The tube may have also created a tighter seal.

2. Using soda water instead of water. Although, using vinegar and citric acid was more effective.

3. Using vinegar instead of water and citric acid.

WHAT DIDN ’T WORK AND SOURCES OF ERROR

1. When we added the tube sometimes the whole tube blew off. How can we stop that from happening?

2. Sometimes the fins on the back of the rocket blew off. Would that have affected the flight time? See picture.

3. It was hard to keep the amount of water we pumped consistent.

IDEAS FOR FUTURE RESEARCH FROM OUR FEEDBACK

ENVIRONMENT

- What is the ideal ratio for the fuel (reactants) so we don't waste reactants and use our fuel responsibly?

AERODYNAMICS

- Does the nose and tail shape affect the time it flies?

ACCURACY

- How can we measure how high the rocket flies?