Lesson #1 Antacid Rockets

"For once you have tasted flight you will walk the earth with your eyes turned skywards, for there you have been and there you will long to return"
Leonardo da Vinci

Grades: K - 4
Duration: 45 minutes

Engineering Criteria: Design a rocket that goes as high as possible.
Design Constraints: Materials limited to antacid, water, vinegar.

Legendary Chinese inventor Wan Hu attempting to launch into the air with his "rocket chair". He did not reach space, and in fact didn't survive this experiment, but did land in the history books as the first recorded individual to have attempted manned rocket flight.

Lesson Focus:
- Students will be introduced to the idea that when scientists conduct experiments they must determine if the experiment is truly a fair test.
- They will understand and identify variables that can change an experiment's outcome.
- Students will also be introduced to the Engineering Design Process. This lesson doesn't work in depth with this concept, but will lay the foundation for further investigations in the lessons that follow.
- Students will compare the effects of altering one variable in launching an antacid rocket.
- They will measure and record how long each rocket takes to launch and how high it goes.

This lesson can be done as a whole class activity or, with older students, they can be organized into partners or groups (2-4) to conduct the experiment on their own.

Ask
What are ways that people fly?
How do we get as far as outer space?
What will happen when we mix an antacid tablet with water in a film canister?

Imagine
What are variables we could change to make our antacid rocket to go as far as possible?

Plan
What will we do to test our ideas?

Create
Have students carry out the plan for testing.

Improve
What have we discovered from our tests? Which variables have a positive impact on the distance the rocket travels?

Ask / Reflect
Which variables had the biggest positive impact on the distance the rocket traveled?

Materials:
- Antacid Tablets
- Water
- Plastic 35mm film canisters .There are two types, the ones that work for rockets have internal sealing lids, as opposed to the kind whose lids wrap around the canister rim. It is simplest to use a permanent marker to pre-mark the containers at 10, 20 and 30ml.
- Timer (s)
- Meter / Yard Stick (s)
- Eye Protection
- Lab worksheet
- Copies of Engineering Design Process flow chart (or simply display in larger format so the whole class can observe it)
- Copies of Antacid Rocket worksheet

Activity Step-by-Step

Ask
What are ways that people fly?
Possible Answers: planes, helicopters, gliders, parachutes

Some people fly to space, how do they get there?

Tell students that they will be launching rockets today and will be conducting an experiment to determine which mixture of "fuel" makes a rocket go farthest.

Tell them that they will try rockets with different amounts of water in each.

Guide the students in discussing how to make sure this is a fair test.
Talk about what "fair" means and how it is applied in different situations.
"Fair" in this instance means we are making sure everything is equal with the exception of one variable.

Analogies one could use when talking about "fair tests";
- If two students were in a race and one had their shoes tied, would that be a fair contest?

- If a teacher gave a math test and one student could use a calculator, phone a friend or ask the teacher for help and the other couldn't, would that be a fair way to determine which was better at math?

The variable is what we want to test and manipulate in order to determine its effect. Tell them that today's variable is the type of liquid being used. Depending on student responses and abilities, develop the concept of variables by posing questions such as;
"What if we put more water in one rocket than another?"
"What if we used two different types of containers or sizes of antacid tablets?"
"What if the temperatures of the two liquids are different?"

Examples for variables that are comprehensible for these grade levels;
- Weather (changing day to day)
- Clothes you choose to wear
- Emotions

Finally, show a diagram of the Engineering Design Process and tell them that this is what engineers use to create, test and improve things they make.

Imagine
Ask students which amount of water they think will make the rocket go farthest.

Plan
Review the steps they will take to conduct their fair test.
A worksheet will be used to help them follow the steps and record their data.

Create
Either as a whole class watch and record each trial or older students may work with partners to carry out the test.

Whole Class Approach
If you decide to use the whole class approach, call up student lab assistants to help prepare and launch the rocket.

Lab Assistant Positions: Timer, Lid-fitter, Antacid Placer

Tips:
- If you have the students work in small groups, limit how much antacid they are given at a time. The thrill of exploding rockets can drive students to experiment with multiple pieces of the antacid in one launch and then they are left with nothing to conduct further trials.
- Dropping the antacid in vinegar causes a very quick reaction. Put the cap on quickly!
- You can place the "rocket" lid right side up or face down. If you place the lid face down, the liquid will pour out when it explodes. It's a good idea to do it on a tray or in a tub. If you launch with the lid facing up, just the lid will go flying. Perhaps this might be described more as launching a flying saucer rather than a rocket.

- Measuring the actual height of the rocket's flight is a bit tricky. One could make measurements on a wall and try to judge the rocket's altitude when it flies. Another approach is to simply observe the rocket's flight and then stand on a chair and use your hand to estimate its height and use meter sticks or measuring tape to gauge how high it reached.

Time to Launch!!

1. Place varying volumes of water in the film canister ranging from 10, 20 to 30ml.
2. One could also use a permanent marker to draw a line at the halfway point of the canisters before the experiment starts.
3. Drop in half an antacid tablet.
4. Quickly affix lid and place on tray / tub on floor.
5. Have designated Timer begin timing.
6. Watch and wait.
7. Record approximate height and time it took before exploding.
8. Conduct experiment twice for each liquid, twice with water then twice with vinegar.
9. Have students determine which liquid launched their rocket highest.

Post Activity

Have students report results. One way to record data is with a simple tally chart comparing how many groups found vinegar to go highest vs. water. One could also list the measurements recorded for each and find the average height reached for each. Depending on how much time you want to devote to the lesson, one could also compare how long it took the rockets to explode and how high they went. Guide the students in looking for patterns and elicit further questions which they will generate while looking at the data. Revisit their hypotheses and determine which was correct, or if further tests might have to be done. Focus their attention on referencing the data to support their claim about whether vinegar or water propelled the rocket higher. Finally,

Assessment

Younger Students
Ask the students what other variables they could change to make the rocket go higher or launch faster.

Older Students
Have students draw a diagram of the experiment on their worksheet.. Diagrams should include labels for the components of the experiment. They might also divide the diagram into two halves and indicate the height each type of rocket reached.

Guide the students in completing the **Analysis** and **Conclusion** portion of the worksheet.

Sample Sentence Frames

Based on our results, I claim that *Vinegar / Water* *launches a rocket higher because our data showed that the rocket with* *Vinegar / Water* *went ____ cm high.*

My hypothesis was *supported / not supported* *by the results of the experiment. Our data showed that* *vinegar /water* *launched the rocket the highest.*

Teacher Tips & Tricks

What's going on scientifically in this lesson?

Antacid releases **carbon dioxide** when it's placed in water. When enough carbon dioxide has built up within the film canister the pressure forces off the lid and sends the canister flying.
The chemical equation for antacid in water is;

$3HCO3– + 3H+ \rightarrow 3H2O + 3CO2$

This is also an example of Newton's third law of physics; F*or every action there is an equal an opposite reaction.*

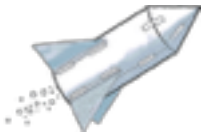
How does this lesson relate to the real world?

Real rockets use a variety of fuel systems to reach escape velocity. Some rockets use solid propellants while others use liquids, or a combination of the two. In every case, engineers must use an oxidizer to maximize the burn rate of the fuel. The ratio of oxidizer to fuel is known as the mixture ratio. This is similar to our antacid experiment in which we experiment with the ratio of mixture between an antacid tablet and different amounts of water.

What are variations I can do in regards to the lesson or materials?

- If you have the students work in small groups, limit how much antacid they are given at a time. The thrill of exploding rockets can drive students to experiment with multiple pieces of the antacid in one launch and then they are left with nothing to conduct further trials.

- You can place the “rocket” lid right side up or face down. If you place the lid face down, the liquid will pour out when it explodes. It’s a good idea to do it on a tray or in a tub. If you launch with the lid facing up, just the lid will go flying. Perhaps this might be described more as launching a flying saucer rather than a rocket.
- Measuring the actual height of the rocket’s flight is a bit tricky. One could make measurements on a wall and try to judge the rocket’s altitude when it flies. Another approach is to simply observe the rocket’s flight and then stand on a chair and use your hand to estimate its height and use meter sticks or measuring tape to gauge how high it reached.



Antacid Rockets

Engineer(s) Name(s):_____

1. **Question**: Which amount of liquid will launch a rocket the farthest?

2. Hypothesis: Which amount of water do you think will launch it farthest?

10ml, 20ml or 30ml?

My hypothesis is that _____ will launch the rocket highest.

What will you measure during the experiment to see if your hypothesis is supported by your data?

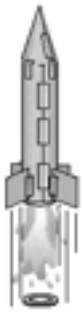
During the experiment I will measure and record _____

_____.

3. Materials: *Antacid Tablet, Water, Film Canister, Timer, Ruler, Eye Protection, Graduated cylinder*

4. Procedure:

a. Fill the canister with a measured amount of liquid
b. Drop in ½ a tablet of antacid.
c. Firmly place lid on canister.
d. Flip canister upside down.
e. Time how long it takes to launch.
f. Record how far it goes.



Draw a diagram which helps explain how the rocket worked

NOTES
Data / Observations

5. Data

Amount of Liquid	Distance (cm)	Time to Launch
10ml	cm	
20ml	cm	
30ml	cm	
	cm	

Observations

6. Analysis

What was the farthest distance your rocket traveled? _____cm

Which amount of water was in that rocket? _____

Based on our results, I claim that _____ launches a rocket farther because our data showed that the rocket with

_____ traveled ____ cm.

7. Conclusion

My hypothesis was _____ by the results of the experiment.
(supported / not supported)