



DIY Air Force Activities:

Rad Rocket



Materials:

- plastic bottle (water bottle or similar sized)
- carrot
- marker
- butter knife
- 3 unsharpened pencils
- tape (masking or duct tape)
- tissue, napkin or paper towel
- baking soda
- vinegar



There are few things as awe inspiring as watching a rocket launch. They blast off using the power of Newton's Third Law, which states that for every action there is an equal and opposite reaction. Think of an inflated balloon, if you release the air in the balloon, it is propelled forward! In order to launch a rocket, the force resulting from the propellant (thrust) must be greater than the forces resulting from friction (drag) and gravity (weight). A rocket engine is a reaction engine. Following the instructions below you will ignite a reaction between baking soda and vinegar to propel your homemade rocket to amazing heights!

Directions:

1. Tape the pencils to the outside of your bottle eraser side up. Leave about 2 inches above mouth of the bottle and make sure they are equally spaced. Now turn the bottle upside down to make sure it stands! Make adjustments as needed.
 2. Push your carrot into the mouth of the bottle as far as it can go. Use your marker to mark where the carrot meets the edge of your bottle.
 3. Remove the carrot and use the butter knife to cut 1 inch above and 1 inch below the mark you made.
 4. Pour white vinegar into your bottle, the liquid should be between 1-2 inches deep.
 5. Unfold your tissue, napkin or paper towel. Pour ~1 heaping tablespoon baking soda onto the center.
 6. Lift each of the 4 corners (a) and twist them together (b) to form a loose pouch of baking soda.
 7. **TAKE THE BOTTLE, BAKING SODA POUCH, AND CARROT STOPPER OUTSIDE.** Place the bottle on the ground with the carrot stopper next to it. Make sure the mouth of the bottle is dry and **CAREFULLY** wiggle your baking soda pouch into the mouth of the bottle taking care not to tear it or drop it in too soon.
 8. Now **QUICKLY** drop the pouch into the bottle and **IMMEDEATLY** shove the carrot stopper **snuggly** into the mouth of the bottle.
 9. Flip the bottle over onto its legs and **back up** and wait for launch!
- Record the height and distance your rocket travels and then experiment with the design to reach greater heights!

Air Force Associations:

Cape Canaveral Air Force Station in Florida has been the historic site of US space launches. As the new space age unfolds and more companies and partnerships seek to travel into outer space, launch pads that once sat vacant are stretched to capacity! The Space Force plans to update Cape Canaveral and its sister range at Vandenberg Air Force Base in California over the next decade to meet this growing need!

<https://www.airforcemag.com/article/building-the-space-range-of-the-future/>

Step 1:



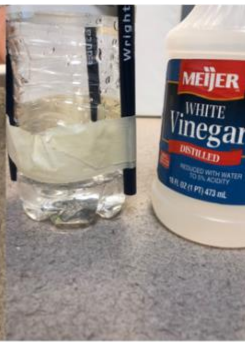
Step 2:



Step 3:



Step 4:



Step 5:



Step 6 a:



Step 6 b:



Step 7:



Step 8:



Step 9:



Rockets are propelled by chemical reactions. In our “engine,” the baking soda reacts with the vinegar to form carbon dioxide gas. Since your bottle rocket is sealed, that gas builds up with nowhere to go, creating a vast amount of pressure. When the pressure becomes too great, the rocket is launched by the force of the gas escaping. This force must be greater than the weight of the rocket (gravity x mass) and the friction created when it moves through the air (drag). The action of the pressure release creates a reaction of forward thrust that propels your rocket through space! Experiment to find the best ratio of vinegar and baking soda to achieve the highest launch! Record your observations!

$$\text{Resulting force} = \text{Thrust} - \text{drag} - \text{weight}$$

