

Breaking Barriers

Sally Ride and Mae Jemison were two of the first women to break barriers in the Space Program at the National Aeronautics and Space Administration (NASA). Dr. Sally Ride was the first woman, and youngest American, in space when the space shuttle *Challenger* STS-7 was launched on June 18, 1983.

Mae Jemison, seeing Sally Ride become the first woman in space, applied to the astronaut program at NASA in 1987. Receiving her first mission on September 28, 1989 when she was selected to join the STS-47 crew as a Mission Specialist, Jemison became the first African American woman in space aboard the space shuttle *Endeavor*.

Both of these women had to be strong and to fight through adversity as women in a male dominated profession, but their hard work and perseverance helped to pave the way for women in space!



Now it's your turn!

Astronauts can't get to space without a rocket, so let's build one!

Film Canister Bubble Rockets

What Is It?

Astronauts can't get to space without a rocket, but what is a rocket and how does it work? A rocket is a container propelled in one direction by exhaust going in the opposite direction. Rockets help spacecraft get into space, stay in space, and maneuver in space. The main parts of a rocket include the nose cone (the leading, tapered section that reduces aerodynamic drag), the body tube (the central structure, which includes the engine, propellant tanks, and payload), and the fins (which guide the rocket).

Using a film canister, seltzer tablets and water (or baking soda and vinegar), this activity is a simple demonstration of a rocket launch and Newton's Laws of Motion.

How Does It Work?

When you combine a seltzer tablet and water (or baking soda and vinegar), a chemical reaction occurs that produces carbon dioxide.

As the CO₂ builds up, the pressure inside the canister increases and eventually provides enough force to break the seal of the canister's cap. This is what provides the force—or push—that launches the rocket.

Newton's Laws of Motion

First Law: Every object in a state of uniform motion will remain in that state of motion unless an external force acts on it. The rocket lifts off because of the force produced when the lid blows off by the gas formed in the canister.

Second Law: Force equals mass times acceleration. The amount of force is directly proportional to the mass of water and gas expelled from the canister and how fast it accelerates.

Third Law: For every action, there is an equal and opposite reaction. The rocket travels upward with a force that is equal and opposite to the downward force propelling the water, gas and lid.

$$F = ma$$

F = the net force on an object

m = the mass of the object

a = acceleration, the rate of change of the object's velocity over time (dv/dt)

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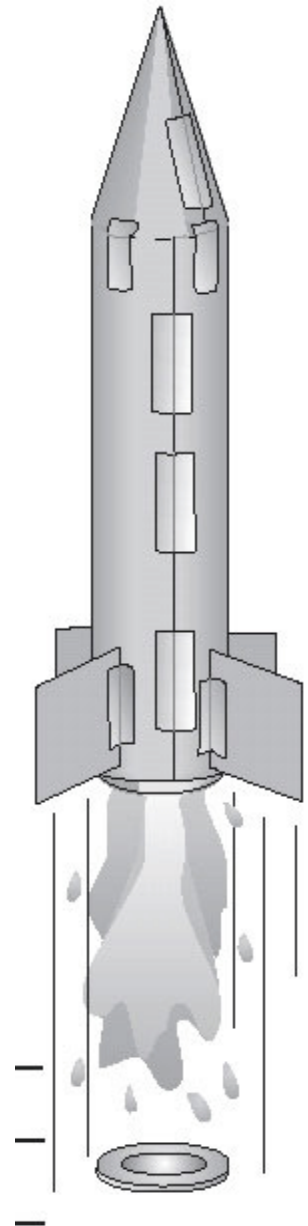
What You Will Need:

- 8.5x11 paper (printer paper or construction paper)
- Nose cone and fins template (Attached)
- 35 mm film canister* (See diagram below)
- Scotch tape
- Scissors
- Antacid fizzy tablet, cut in 1/2* (See notes)
- Paper Towels
- Water
- Eye protection

Notes:

1. You can also do this experiment using baking soda and white distilled vinegar. See substitution notes in experiment instructions.

Diagram 1a: The film canister MUST be one with a cap that fits INSIDE the rim instead of over the outside of the rim (as pictured).



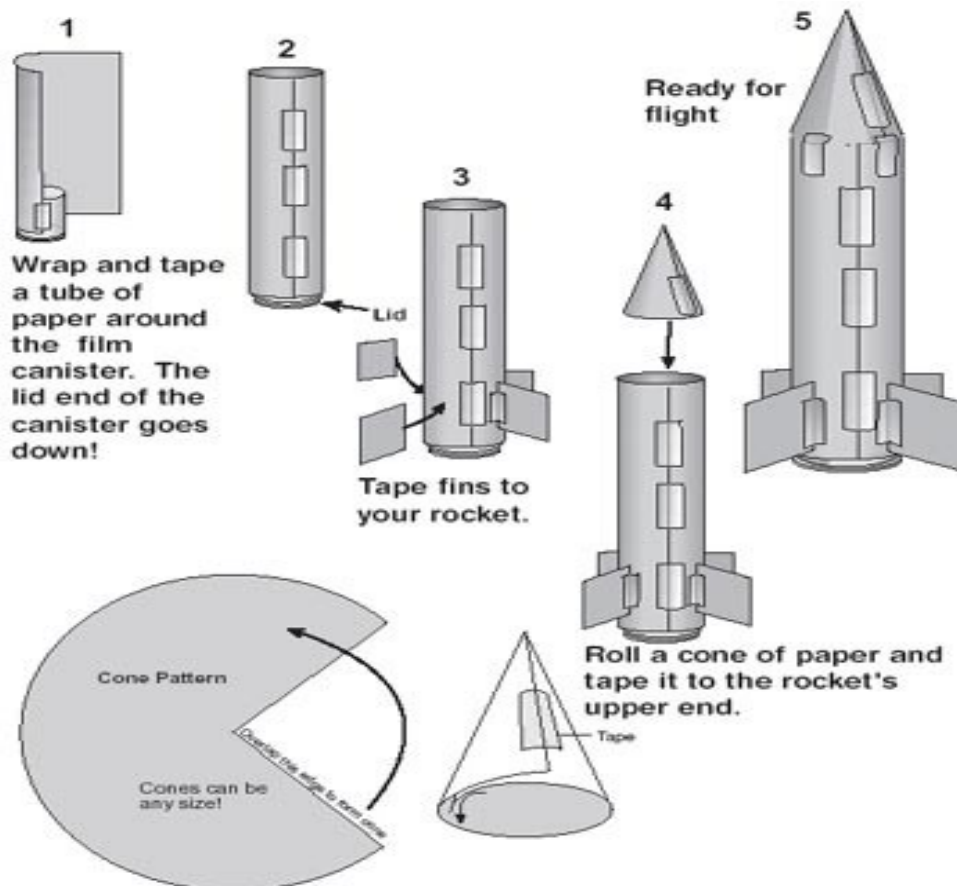
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Making the Rocket

Using the template provided, cut out all the pieces for your rocket

1. Using either the long or short end of the paper, place the lid end of the canister down and wrap and tape paper around the film canister
2. Tape fins to your rocket body
3. Roll the circle (with a wedge cut out) into a cone and tape it to the rocket's top.

* **Helpful Hint:** Tape the canister to the edge of the paper before you start rolling paper around the canister.



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3...2...1...Launch!

1. Put on your eye protection (eyeglasses or sunglasses will work!)
2. Turn the rocket upside down and remove the canister's lid
3. Fill the canister one-third full of water

Now work quickly on the next steps!

1. Drop one-half of an effervescent antacid tablet into the canister ***
2. Snap the lid on tight
3. Stand your rocket on a launch platform, such as your sidewalk or driveway
4. Stand back and wait. Your rocket will blast off!

*****If you don't have effervescent tablets, you can substitute baking soda and vinegar. Measure 1 teaspoon of white vinegar into canister. Before launch, add 1/2 teaspoon of baking soda to canister and quickly put cap back on.**

