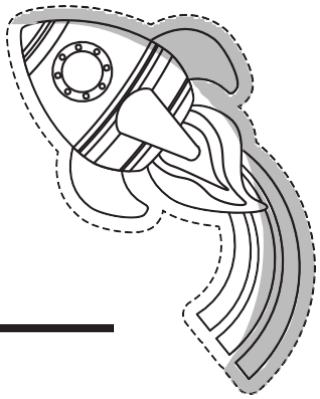
BOTTLE ROCKET



This experiment demonstrates how a built up in pressure can launch a rocket with just water and air. No Jet fuel required because that's just dangerous. Children can construct individual rockets or make them in groups of 2 or more. Suitable for ages 9yrs +

What you need to make one

- An empty plastic bottle (2L coke bottle style)
- Cardboard to make into a cone and 4 fins
- A cork
- ½ a cup of Playdoh for Ballast
- A stand-up bike pump - you can use a handheld bike pump but it's much harder
- A pump needle adaptor (the type for inflating basketballs or netballs)
- Water
- Waterproof tape like duct tape or gaffer tape

What you could also use (optional)

- A foam pool noodle
- A Bucket
- Some bits of wood to use as a launch pad
- A low temperature hot glue gun

Instructions

1 Create your nose cone

There are heaps of ways to create a nose cone. Be sure it is big enough to cover the top of the rocket.

Style 1 - Cardboard / Paper with tape

1. Roll a piece of paper/ card into a cone. This will be the nose cone of the rocket. Feel free to use colored or patterned paper to design the rocket. Glitter looks great in space.
2. Wrap the nose of the cone with duct tape. This will make it stronger and more water-resistant.

Style 2 - Foam tubing

1. Cut a foam pool noodle to create a bumper for the nose of the rocket.
2. Glue or tape onto bottle

2 Make your fins

1. Take thin cardboard and cut out 3-4 triangles. Since these will be the fins of your rocket, try to cut them at perfect right angles so they can help the rocket stand straight.
2. Use cardboard, construction paper or normal paper as material for the fins. Sign boards, such as the ones that say “For Rent” or “For Sale” are also very good fin material.
3. Place the fins on the lower part of the rocket.
4. Bend “tabs” into the sides of the fins so that they can attach to the rocket body more easily. Then, tape or glue them on.
5. If you line up the bottoms of the fins with the bottom of the rocket, it should be able to stand on its own.

3 Add Ballast

1. Add ballast to give the rocket weight so it will go farther and ensures the rocket can coast once it is launched. The heavier the rocket, the less wind will slow it down but be careful the more weight you add the harder it will be to blast off! Ballast can be any material that provides weight for the rocket but let’s use Play Doh or clay as ballast as it is soft, malleable, and unlike pebbles or marbles, won’t fall out or scatter when the rocket launches.
2. Mold about half a cup of Play Doh or clay into the ridges on the bottom of the bottle to form a rounded end on the outside of the bottle.
3. Cover it with duct tape to keep it secure.

4 Fill & secure your bottle

1. Fill up the bottle with water. Fill the bottle one quarter full of water or pour up to 1 litre of water into the bottle.
2. Make a very small hole through a cork. Make sure the hole is the same size as the valve of your bicycle pump valve.
3. Stuff the cork into the bottle opening. You can also wedge it in with pliers for a tighter squeeze.
4. Push the needle adaptor of the pump through the cork, it needs to go all the way through, so you might have to trim the cork a little bit.

5 Attach the nose cone

The nose cone will make the rocket more aerodynamic… and look more like a rocket.

1. Attach the nose cone to the bottom of the bottle. If you are using the advanced digital sensor to measure height, use duct tape so you can easily remove it to get reading from the sensor.
2. Try to put it on a straight as you can onto the bottle and make sure it is secure.

6 Launch your rocket

Make sure you are in an open, outdoor area. The rocket will shoot up quite fast and high so remove any obstructions and warn anyone around you before you launch it. Please make sure an adult is around as the rocket takes off very suddenly and forcefully.

1. Place the rocket on its fins so it stands up on its own or If your rocket won't stand up on its own, try putting it into a bucket with a hole cut in it for the air pump or sitting it on two bits of wood
2. Pump air into it. The rocket will go off when the cork can no longer withstand the pressure building up in the bottle.
3. The water will shoot out everywhere when the bottle rocket takes off, so be prepared to get a bit wet. If you don't want to get wet, try setting up a shield between you and the rocket
4. Do not approach the rocket once you start pumping, even if it appears that nothing is happening with the launch, as this can lead to injury. IF it is not launching try pumping more as it probably hasn't built up enough pressure.
5. Watch the rocket fly into the air. Wait for it to safely land then collect it.

The science bit

Space rockets work in a similar way to the bottle, but instead of squirting water they burn fuel to make a powerful jet of hot gas. The force of the gas downwards pushes the rocket upwards.

Isaac Newton worked out the three laws of motion which describe how all objects move. The third law says:

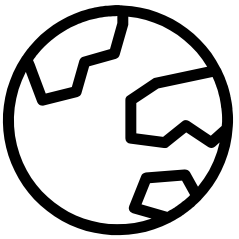
'for every action there is an equal and opposite reaction'

- Isaac Newton

This is demonstrated by the bottle rocket.

As we pump air through the water the pressure inside the bottle builds up until the force of the air pushing on the water is enough to push the cork out of the end of the bottle. The water rushes out of the bottle in one direction whilst the bottle pushes back in the other. This results in the bottle shooting upwards.

What they are learning



Students explore Newton's Laws of Motion, forces, ballast, momentum, and propulsion. Students design and build water bottle rockets. Students test the effects of ballast, fin design, and percentage of water to air mixture on the maximum height of a water bottle rocket. Equipment and materials include a water bottle launcher, air pump with pressure gauge, altimeter, and materials for building water bottle rockets.

Intro to Aerospace Rocketry
Students learn basic science concepts related to aerospace rocketry technology. Students also explore the history of aerospace rocketry and aerospace careers.

Aerodynamics - Nose Cone Shape
Students explore how the shape of a rockets nose cone affects the drag on the rocket.

Ballast - Nose Mass
Students explore the purposes of ballast in a rocket. Students explore how the rockets ballast affects the maximum altitude attained by the rocket.

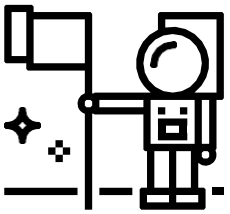
Fins
Students explore the purpose of fins on a rocket.

Propulsion
Students hypothesize what mixture of water and air will produce the optimum propulsion for a rocket. Students test fuel mixtures on rockets of the same design. They gather and analyze their data to determine the optimum mixture.

Rocket Design Challenge
Students use the information learned in live stream to design and build a rocket to see who can fly the highest. Students test and redesign their rocket as necessary.

In class activity: Students write and present a report describing their design, the reasoning behind their design, and their rockets performance.

Other things to try with your Rocket



Trying Different Amounts of Water

What difference does the amount of water you put in the rocket make?

You will need a way of measuring the effect. You can measure distance or use your watch to time the number of seconds that the rocket is in the air.

First, try launching your rocket without any water in it. Try subsequent launches with 100 ml, 200 ml, 300 ml, 500 ml, 750 ml and 1000 ml.

Don't use more than 1 liter of water (1000 ml) or the weight of it will bend and crush the fins before the rocket lifts off!

Which one stays up the longest? Why does the amount of water make a difference?

What Effect Does Dish Soap Have?

Adding lots of foaming dish soap to the rocket water seems to make the rocket go much higher. How much soap makes it go the highest? And how much higher does it fly?

Just before pumping up each rocket with soap, make sure to really shake the rocket so that the soap foams up as much as possible. Launch your rocket with 300 ml of water (without soap) and
measure how long it stays up in the air. Then launch it with 50 ml of dish soap and 250 ml of water and measure. Then 100 ml of soap and 200 ml of water and measure.

Why does the foamy water make a difference to how long the rocket stays up?

Make the Fins Spin the Rocket

Try gluing the fins on at an angle. All three fins should be at the same angle, so that when the rocket flies, the air going past the fins will make the rocket spin slowly (for a small fin angle) or vigorously (for a steep fin angle.

Try to think of your own experiments to do with your rocket. Always think ahead to keep in mind the safety of yourself and others.

Homemade water rocket troubleshooting & maintenance

Water rocket troubleshooting is easy if you make use of the following simple ideas!

Rocket loses a fin on impact with the ground: Using your low-temperature hot-melt glue gun or tape, just put it on again and you're back in business!

Rocket releases too early and doesn't fly high enough: Push the cork in much farther! The farther you push the cork in, the higher your rocket will fly! But don't push it in all the way so that it falls into the bottle! Who needs to tell you that? You're a rocket scientist; you know these things!

The wind knocks the rocket over on its side: It's too windy out. Wait for a milder day to do your launching! Or pile some loose dirt around the base of the fins to help keep it upright.

Rocket doesn't take off at all: pump some more. You probably haven't yet put enough pressure into the rocket bottle to push the cork out.

If bottle looks damaged or stretched: then it's time to replace the bottle with a new one. You can usually remove the parts from the rocket using a hair dryer to heat the hot-melt glue, then glue them onto a new bottle.