

3Dkanjers

Developing talent through science and technology

USE THE 3D PRINTER TO BUILD YOUR OWN

BOTTLE ROCKET

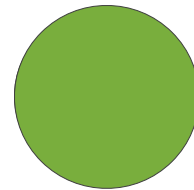


3DKANJERS BOTTLE ROCKET

ATTENTION! READ THIS FIRST.

Launching a bottle rocket is fun, but can also be dangerous. Always do this with adult supervision. Only launch the rocket outside and on an open field. Make sure the rocket can only shoot upward and not sideways. Keep spectators at a safe distance, preferably behind the person who is pumping.

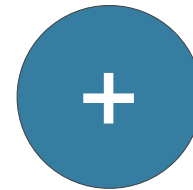
3Dkanjers is not responsible for any damages that may occur during the construction or launching of the bottle rocket.



PRIMARY
EDUCATION

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The pages with a green dot are suitable for students in the upper grades of primary education.



SECONDARY
EDUCATION

SECONDARY EDUCATION

All pages with a blue dot are suitable for students in secondary education. If there is a + in the blue dot, the page is particularly suitable for pupils that are more advanced.

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USE THE 3D PRINTER TO BUILD YOUR OWN BOTTLE ROCKET

WHAT IS A BOTTLE ROCKET?

A bottle rocket is a rocket made of a plastic bottle (a PET bottle), which is propelled by water. By filling the bottle with water and then pumping air into it, the bottle shoots up.

There are different ways to build and shoot a bottle rocket. It can be very simple with just a cork, valve and a bicycle pump, to quite difficult with a special firing mechanism and a parachute.

IT'S NOT JUST COOL!

Shooting a bottle rocket is a super cool thing to do. The world altitude record stands at over 600 meters, and you are probably not going to make it that high. But, you can try to get as high as possible! It is however important to know how a real rocket works

exactly and how you can apply this to your own bottle rocket.

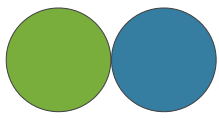
What should the wings look like and where exactly should they be? Should the nose cone be pointed or resemble a hemisphere? Is your rocket balanced properly?

3DKANJERS' BOTTLE ROCKET

3Dkanjers gives you some ideas for building an awesome bottle rocket with the aid of the 3D printer in this construction manual. Ranging from easy to fairly difficult. Our own 3Dkanjers' bottle rocket is used as an example and we hope you surprise us with a much better idea.

We hope you have fun!





DESIGN THE BASE OF YOUR BOTTLE ROCKET

WHAT DO YOU NEED?

It is pretty easy to make a simple bottle rocket using a plastic bottle. You will need:

- A plastic PET bottle. We like to use the S. Pellegrino bottle.
- A cork that fits well in the bottle.
- An old bicycle tire with a valve.
- A long bicycle spoke, a thick straw and tape (this will be used to guide the rocket).
- Cardboard for the wings.
- Water and a bicycle pump.

HOW DO YOU MAKE IT?

First, you'll cut the cork down to size, so it fits in the bottle. Then you'll cut out the valve from the tire and place it into the cork by making a hole in it first. After that you tape the straw to the bottle.

Fill 1/3rd of your bottle with water and put the cork in the bottle. Push the bike spoke deep into the ground and slide the rocket over the bicycle spoke. Connect the bicycle pump to the valve and start pumping. After a few pumps, there will be so much pressure in the bottle that the cork pops out and the bottle flies away.

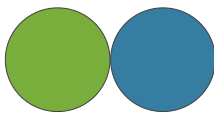


Air pressure

Air is a gas. You can't hold or touch it, like you can with water. If you compress a gas, for example in a bottle, the pressure of the gas becomes greater. This is the same with air. If the pressure gets too high, the air will try to escape from the bottle. Since the cork is the weakest spot in the bottle, the cork will pop out and the air (and water) will escape very quickly from the bottle.

Fun to find out

- What happens if you put more or less water in the rocket?
- What happens if you don't put any water in the rocket?
- Stick some wings on your rocket. Will the rocket fly?
- How does a real rocket work?



EXTENSION 1: WINGS



<https://www.youmagine.com/designs/3dkanjers-waterraket-water-rocket>

Item: Wr Wingholder 3dkanjers

3D printer:

- Layer Height: 0.2
- Fill: 20%
- Platform: Brim

A ROCKET WITH REAL WINGS (FINS)

You may have noticed it when you were launching your bottle rocket. When all the water from the bottle is gone, the bottle will “flutter” in the air and lose speed and altitude. By adding fins to the rocket, you can make the bottle more stable and keep it pointed straight up during the flight.

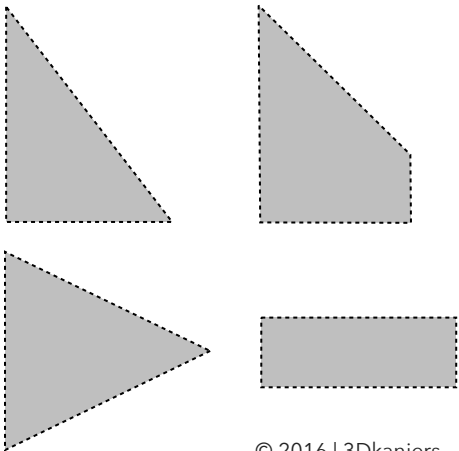
You can cut fins out of cardboard and stick them on the bottle, but they will not stay on properly. It looks nice, but it doesn’t work. 3Dkanjers has designed a handy fin holder that you can print with the 3D printer. They can be found on youmagine.com. Put the fin holder around the neck of the bottle (S. Pellegrino PET bottle) and secure it with a rubber band.

Cut three wings out of thick cardboard (> 5 millimeters) and slide them into the slots. Launch your rocket again and see if your bottle rocket is now more stable and stays in the air longer.



Type of fins

Look on the Internet and google “wing shapes rocket”. You will see that there are numerous forms you can choose from. Make a few with cardboard and try them out. You may discover which fin works best.



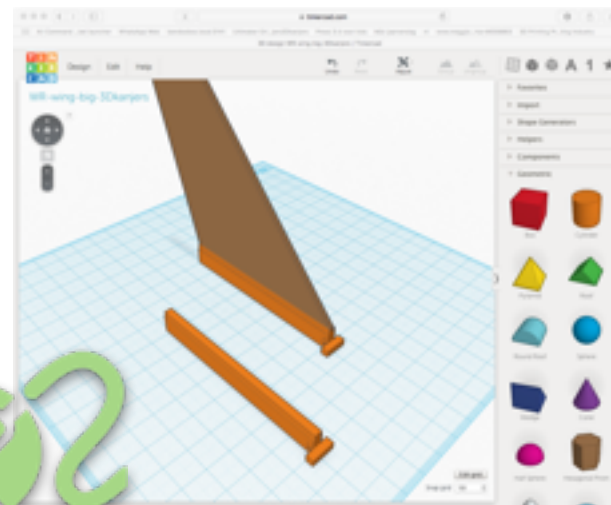
EXTENSION 2: SUPER WINGS

DESIGN YOUR WINGS WITH THE 3D PRINTER

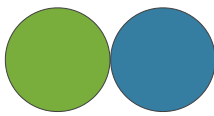
You can also design your wings (fins) in Tinkercad and then print them on your 3D printer. With Tinkercad you actually have quite a lot of freedom. For example, you can design a fin that is slightly slanted. Your bottle rocket will start to rotate around its axis in the air, which will increase the stability.

DESIGN AND 3D PRINTING TIPS:

Design your fin with the fin base we have created for you, since it fits into the fin holder exactly. A fin thickness of 2 mm is sufficient. 3D print the fin with a "layer height" of 0.2 and use a "brim". If you remain above 45 degrees in your design, you do not need support.



<https://tinkercad.com/things/hvCw1jFdMLB>



EXTENSION 3: NOSE CONE



<https://www.youmagine.com/designs/3dkanjers-waterraket-water-rocket>

Item: Wr Cone 3dkanjers

3D printer:

- Layer Height: 0.2
- Fill: 20%
- Platform: Brim

INCREASE YOUR ROCKET'S WEIGHT AND BALANCE

The bottom of the bottle (the top of your rocket) is fairly flat. This produces air resistance. Try waving your flat hand in the air and then try it with your fist. When do you feel the most resistance?

There are three reasons to place a nose cone on your bottle rocket:

1. It reduces the air resistance;
2. Due to the weight of the nose cone, the rocket has a greater mass, which makes the loss of speed smaller and will make the rocket remain in the air longer;
3. It gives the rocket more balance.

Air resistance

Air resistance is the force air exerts on an object when it is moving through the air. By making an object aerodynamic, you reduce this force (resistance). But which shape is most appropriate? Should it be pointed or spherical? Look at how nature has solved this. What shape, for example, does a raindrop or a whale have?

Mass and balance

It does sound strange. By placing a nose cone, doesn't the rocket become heavier, making it harder to go up? Yes, that is true, but the weight also makes the rocket stay in the air longer. So a nose cone should not be too heavy, nor too light. In addition, it's better if the center of gravity of the rocket is just about in the centre. The wings make the center of gravity shift to the bottom. By placing a nose cone, the centre of gravity shifts back to the center more (Think about a seesaw that is balanced left and right).

Fun to design

- You can, of course, download our design as above, but making your own nose cone is much more fun.
- Create an aerodynamic nose cone with the correct weight. Tip! In Cura you can see how heavy your 3D print will be exactly.



EXTENSION 4: PARACHUTE

If the rocket comes back down and has a weighted nose or fins, it will land very hard and it's likely that the rocket will break or get severely damaged. That's why it's desirable to add a parachute.

You can attach a loose nose cone onto the bottle, which can come off. Underneath the nose you place a parachute. When the bottle is at its highest point, the nose will fall off, allowing the parachute to unfold.

Good materials to make a parachute with are, for example, the fabric of an umbrella, a plastic bag or an extra-large sandwich bag.



<https://www.youmagine.com/designs/3dkanjers-waterraket-water-rocket>

Item: Wr Cone Para 3dkanjers (5 & 6)

3D printer:

- Layer Height: 0.2
- Fill: 20%
- Platform: Brim

3Dkanjers has designed a special nose cone that consists of two parts, which can be used as an example. It is, of course, the challenge to devise a whole new design, print and test it out. You can find many examples on the Internet.

EXTENSION 5: FIRING MECHANISM

EVEN HIGHER (AND MORE DANGEROUS)

So far, you have fired the bottle rocket with a cork. The cork shoots out as soon as the pressure in the bottle becomes too high. If you make a firing mechanism, you can boost the pressure in the bottle even higher, allowing the bottle rocket to fly even higher.

Beware! If the pressure in the bottle is too high, the bottle can also burst. Then it becomes too dangerous. Don't pump more than 10 Bar in a PET bottle, between 10 and 12 Bar a PET bottle will explode. This may cause serious injuries to bystanders closer than 10 meters to the launch site. Never sit in front of the launch tube, this too can have very serious consequences. The water is squeezed out of the bottle in approximately 0.1 sec (with a normal bottle neck); the resulting acceleration can be between 100 and 200 G. With a good launch, a speed of 200 km/h can be achieved, this can lead to serious injuries.

3Dkanjers firing mechanism

3Dkanjers made a firing mechanism with the 3D printer. This consists of a special thruster which can be screwed on the bottle and a platform on which the bottle rocket rests. In the platform, the bicycle valve is inserted. The linchpin fits perfectly into the thruster and the platform and is attached to a string. Once the pressure is increased, you pull out the linchpin. **Attention! Our design is a concept, to be used at your own risk.**



<https://www.youmagine.com/designs/3dkanjers-waterraket-water-rocket>

Items: Wr Truster 3dkanjers, Wr Base 3dkanjers en Wr Base Fork 3dkanjers
3D printer:

- Layer Height: 0.2
- Fill: 20%
- Platform: Brim





3Dkanjers

Developing talent through science and technology

3Dkanjers is a unique initiative for schools in the Netherlands and Belgium. We encourage talent development through science and technology with the aid of the 3D printer.

More information about 3Dkanjers can be found at:

www.3Dkanjers.nl