

# Building a Vortex Cannon



Curriculum Relevance: Year 5; forces  
KS3; forces, pressure

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SCIENCE ON FIRE

**Vortex cannons are great fun and you can build them from many different things very easily. They can be used as a start of topic taster or a fun way to end a topic about forces and pressure. They're even more fun if you have a smoke machine!**

## **The Sciencey Goodness**

The basic principle of a vortex cannon is really simple. It's a container with a hole at one end and a means of fairly rapidly increasing the pressure inside that container.



When the pressure increases above the pressure outside the container, the air inside the container is forced out through the hole. This is where it gets interesting.

The air forced out through the centre of the hole can move relatively fast, whereas the air around the outside is somewhat slowed by contact with the edge of the hole and the stationary air outside the cannon. This causes the air on the outside of the ring to bend outwards. However, as the air on the inside of the ring is moving faster, the Bernoulli effect means that it will be at lower pressure so it tends to draw this air back inwards towards the centre and we end up with a vortex.

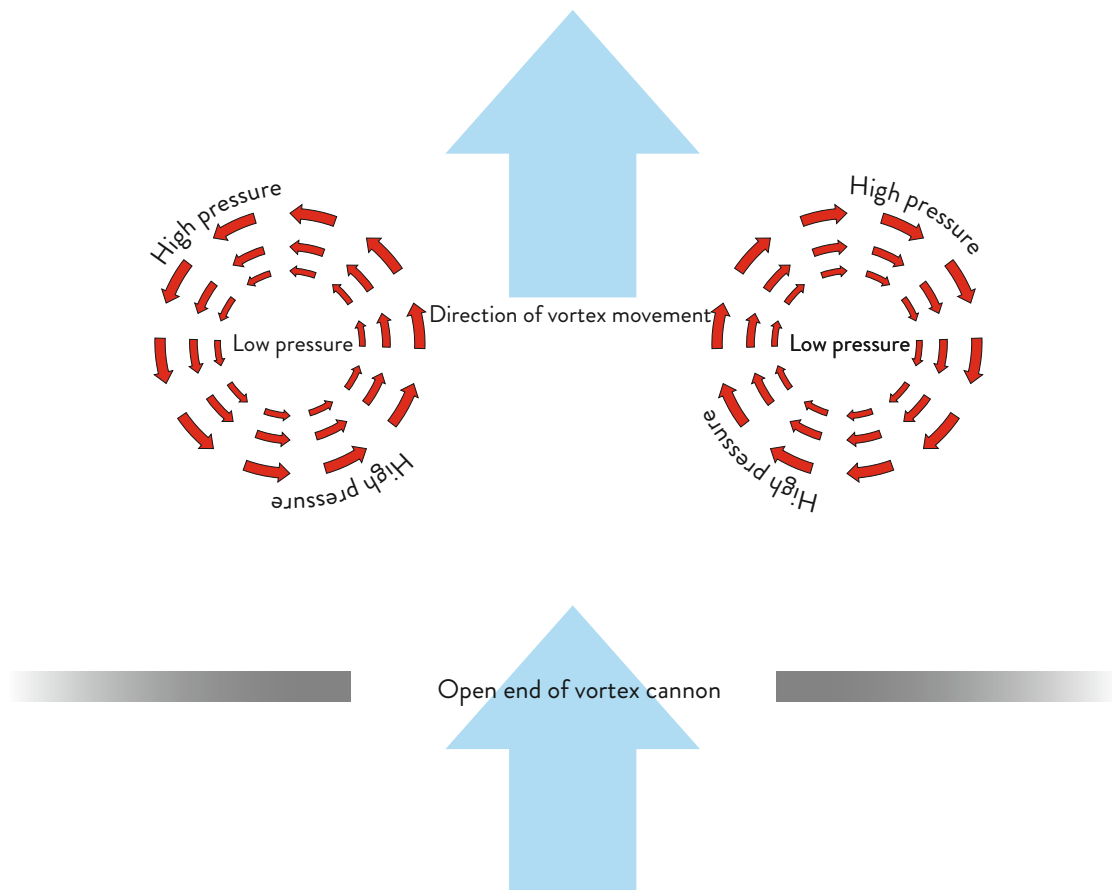
As the body of air as a whole still has some forward momentum, the vortex will travel forwards, and as it's spinning it's at lower pressure than the air around it. That inward pressure from the air around it tends to hold it together. Friction with the air around it means that the vortex will gradually slow down, so the pressure difference between it and the air around it will decrease and the vortex will lose it's structural integrity, gradually dissipating into the air around it.

If you have a smoke machine these vortices can be pretty impressive.

If you don't have a smoke machine you can use these vortices to knock over pyramids of paper cups from quite a distance away.

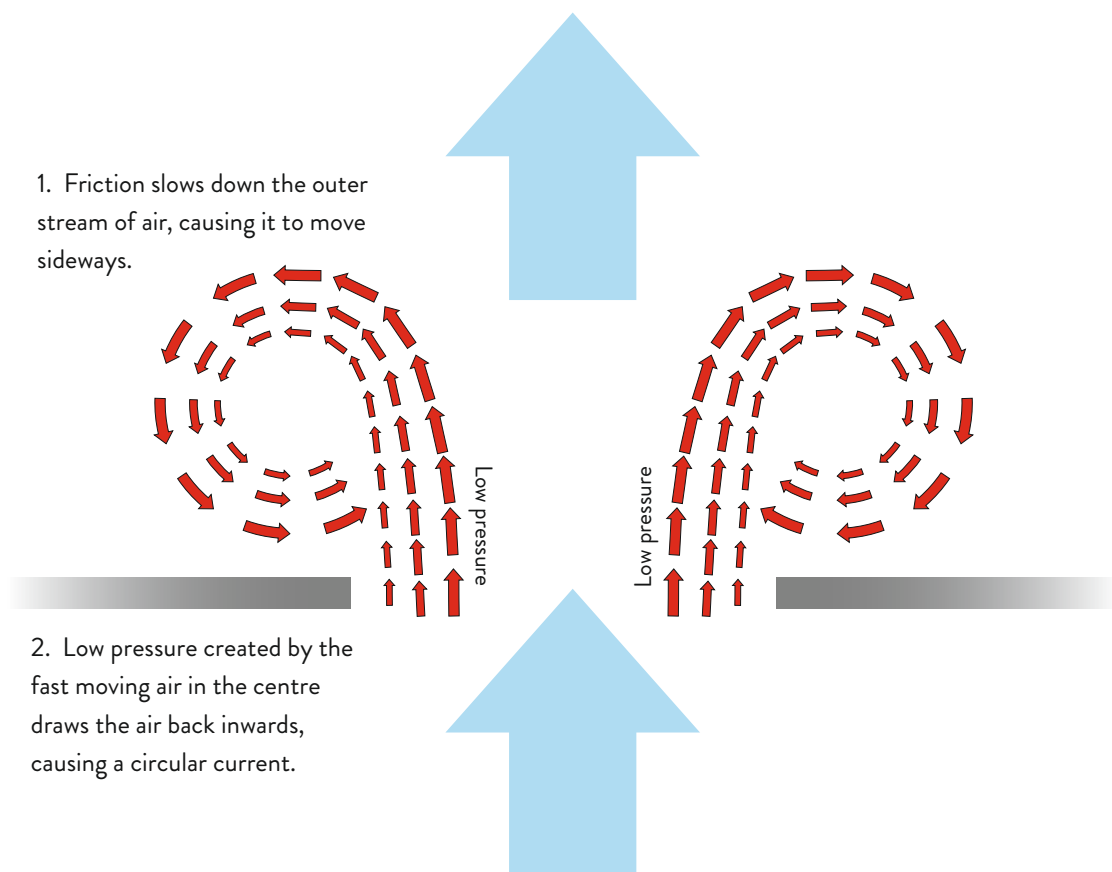
# How a vortex is formed

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1. Friction slows down the outer stream of air, causing it to move sideways.



## Stuff You'll Need

- Firstly, we highly recommend that you get yourself a smoke machine. These can be bought online for £30 to £40.
- A cardboard box for each team building a vortex cannon. We recommend students work on this in pairs or teams of three. A variety of different size and shape boxes would be good. Old photocopier paper boxes work well.
- A bin bag for each team.
- A roll of sticky tape and scissors for each team.
- Some paper cups if you want something to knock over.

## Classroom Use Suggestions

- Arrange students into teams of two or three
- Demonstrate a pre-made vortex cannon and ask students to explain what's happening. Most of the time they can explain why the air comes out of the hole at the front but the difficult part is explaining why the vortex itself forms. An approach that we have found to be effective is to break the explanation down:
  - The first part of the formation of the vortex involves the air moving sideways as it leaves the opening at the front of the cannon. Newton's first law of motion tells us that a force must be acting. Where does this force come from?
  - The second part of the formation of the vortex involves the air moving back towards the opening at the front of the cannon. Again, a force must be acting. It is unlikely that KS3 students will know of the Bernoulli effect but this basically says that an increase in the speed of a fluid occurs simultaneously with a drop in pressure of that fluid. The lower pressure caused by the fast moving air towards the centre of the opening draws the air back towards it, setting up a circular current. The Bernoulli effect can be easily demonstrated by just blowing over the surface of a sheet of paper and observing it rise upwards.
- Get teams to build their own vortex cannons. Printable instruction sheets are included at the end of this document.
- Depending on the time you have available you may want to try some of the following:
  - Have a competition to see who can knock over a pyramid of paper cups from the furthest distance.
  - If you have a smoke machine and a variety of different cannon sizes see if it is possible to fire a small vortex through the centre of a large vortex.
  - What difference does the shape of the cannon opening make? Teams may want to try different shapes by cutting out shapes in card and sticking them over the original circular opening rather than modifying the original opening.

## HAZARDS

This is a pretty low hazard activity. Generally just look out for trip hazards etc as you would for any practical activity.

If you do use a smoke machine with proper smoke fluid there should be no problem. Just make sure that the space is well ventilated so the smoke disperses quickly. Smoke machines will get hot so make sure you have steps in place to stop people burning themselves.

As far as we're aware the smoke fluid used in small smoke machines should not adversely affect anyone with asthma. Please check your particular brand.

## If you've found this useful...

Or if you have any requests or suggestions for more resources then do let us know. You can subscribe to our 'Supercurricular Subscription Service' for more of this kind of thing just go to

[www.wonderstruck.co.uk/resources](http://www.wonderstruck.co.uk/resources)

for more details. It's completely free until January 2020 and then only £5 a month and you can leave at any time.

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# The Mighty Vortex Cannon

## Build Instructions



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### Step 1 The parts



You will need:

- a cardboard box (any size)
- a plastic bin bag
- sticky tape
- a pair of scissors or a craft knife
- access to a smoke machine would be great

### Step 2 Cut a hole



- Draw a circle on the base of your box. The diameter of the circle needs to be about half the width of the base of your box (that's on its smallest dimension).
- Use a pair of scissors to cut out the circle. Using a craft knife would be easier, but you might not be allowed one of those.

### Step 3 Stick on the bin bag



- Cut a piece out of your bin bag that's about twice as long and twice as wide as your box.
- Stick it over the open side of your box so it's a bit baggy. If it's too tight or too baggy it won't work as well. You may have to try a couple of times to get it just right.

### Step 4 Make some vortices!



- Simply point your vortex cannon at what you want to shoot a vortex at and slap the bin bag with your open palm.
- If you've got a smoke machine just fill the vortex cannon with smoke before you use it.