

## Air Cannon

**What to do:** Aim the cannon at the target and thump the block at the rear with the palm of your hand. What happens to the target?

**What happens:** When you thump the barrel, a spinning pulse of air (or vortex) is fired at the target. As a vortex, air travels directly instead of following its usual diverse pathways. Note how small the hole at the front is much smaller than the barrel. This helps create a very powerful, fast-moving vortex.



### HOW IT WORKS

1. The cannon of this exhibit is not empty. It is full of air. When you thump the back of the barrel, the rubber sheeting is pushed into the cannon. This decreases the volume inside the cannon and so increases the pressure. The air inside has less volume to move around. The increase in pressure forces some of the air out of the opening of the cannon.
2. The velocity at which the air leaves the cannon is inversely proportional to the diameter of the hole. The smaller the hole in relation to the size of the cannon, the greater the velocity of the air. You may have seen the same effect when using a hosepipe. If you squeeze the sides of the opening of the hosepipe together, the water comes out with more force.
3. The air cannon can also be called a "vortex generator". The air leaving the cannon is not cannonball-shaped. Although invisible to us, the air actually looks like a flat doughnut (known as a "vortex"), similar to a smoke ring.
4. A vortex is formed because the air exiting the cannon through the centre of the hole is moving faster than the air exiting at the sides. When you aim the air cannon at the target, you can see the doughnut-shaped vortex in the movement of the foil squares.
5. Air is made up of billions of high-energy molecules of gas. The gas molecules are moving very quickly and colliding with objects in their path. When you aim the air cannon at the target, the air molecules hit it, transferring some of their energy and making the foil squares move.
6. The vortex of air is very stable and, depending on the force with which you hit the back of the cannon, it can move in this way for several metres. If you hit the back of the cannon very gently, you do not create a vortex, because the pressure inside the cannon itself does not increase significantly. If you hit the back of the cannon too hard, you produce a confused combination of vortices (known as "turbulence").

7. Turbulence occurs when two bodies of air travelling at different speeds meet. Clear-air turbulence can significantly affect airplane flight. Because aircraft travel at high speeds through these different bodies of air, this can cause sudden unexpected accelerations, which are hazardous for air navigation.
8. Clear-air turbulence can be observed when looking into the night sky. Astronomical objects, such as stars, appear blurred and seem to “twinkle”. This effect is known as “astronomical seeing” and is caused by turbulence in the Earth’s atmosphere.

**DID YOU KNOW?** .....

What we call “air” is actually a complex jumble of many different elements. Air is typically made up of 78% nitrogen and 21% oxygen. The remaining 1% comprises water vapour and numerous other gases, including carbon dioxide and argon.

**WANT TO KNOW MORE?**

To view a similar effect in water, explore **Vortex** in the Water Zone.

The **Pipes of Pan** exhibit uses the same principles as **Air Cannon** to make music.