Vortex Cannons Lesson

Plan

Amount of time demo takes: 3-5 mins.
Try this at home!

Materials

● Vortex cannons or cardboard boxes
● Duct Tape - for boxes
● Box Cutter - for boxes
● Smoke machine and fog juice - Needs electricity
● Large paper/plastic/styrofoam cups
● Large vortex cannon with trigger, be gentle
  (not for participants to use)

Set-up Instructions and Instructional Procedure

1. If using cardboard boxes, tape up the boxes and cut a hole in one of the non-flap sides about 5 inches wide.
2. Fill smoke machine with fog juice.
3. Plug in and turn on smoke machine. Place it on a heat-resistant surface.
4. Wait a few minutes for machine to warm up.
5. Press the remote button for smoke to be released into the cannon. The nozzle for the smoke machine is extremely hot - do not touch vortex cannon/fingers to it!
6. Have someone stand 15-20 ft away with a cup on their head or set up a tower of cups on a table and aim the cannon from 15-20 ft away.
7. Pull on the back of the cannon, and aim at the person’s head. Fire it -- a smoke ring should come out! The smoke ring vortex will travel to the target and knock over the cup(s). You can do this demo without smoke, but you will not see the vortex traveling.

SAFETY!

● If people have asthma or other respiratory problems, the smoke may be irritating to them.
● The smoke machine gets very hot - do not touch nozzle where smoke is released. Keep the smoke machine on a heat-resistant surface.
● Turn off smoke machine at least an half hour before packing up to ensure
it is cool enough to pack.

- Make sure the area stays well ventilated. If the area starts to become too foggy, open doors and windows, or shut down temporarily. You could also switch to just using a single fog machine.

**Lesson's Big Idea**

- In this demo, we refer to air (the smoke) as a liquid.
- Vortex rings are an example of rolling donut-shaped toroids of a fluid (most often air, and sometimes water). Because of the way they rotate, a vortex ring can hold itself together and travel for quite a distance. This can be partly explained using what is called the Bernoulli Principle.
- Bernoulli's principle is based around the principle of energy conservation. This states that, in a steady flow, the sum of all forms of mechanical energy in a fluid along a streamline is the same at all points on that streamline. This requires that the sum of kinetic energy and potential energy remain constant.
- Faster-moving liquids (air in our example) have lower pressure when moving horizontally than slow-moving liquids. Fluid particles can change speeds based on whether they are in a low or high pressure area.
- When you fire the vortex cannon, a puff of air is being shot out into the surrounding air, which is presumably much calmer. The fast-moving air pushes the other particles ‘up-and-out,’ which helps to form the ring that we see. When you pull back on the elastic and release, kinetic energy is transferred between air particles. This is what propels the ring. The core region (‘hole in the donut’) never changes - the air on the outside is set in motion by the approaching ring. The smoke in the core area of the ring will dissipate and the smoke ring will remain stable as it travels. The smoke travels in a ring shape because a vortex was created.

**Additional Information**

- If students express further interest in the vortex cannon, tell them how to make one at home. This can be done with simply a cup/oatmeal canister/etc., scissors, and a balloon or bag.
Assessment/sample questions to ask
1. What is the ring that comes out of the cannon called?
2. Why is the ring of air able to knock things over?
3. Where else in nature/everyday life do we see vortices of various kinds? (a sink drain, a tornado/hurricane/microburst, etc.)

Clean Up
● Turn off smoke machine one hour before cleaning up to ensure it is cool enough to pack. Disassemble the cannons to store them neatly into their large bin.
● **IMPORTANT:** Do not simply crush the cannons to be stored, there are small plastic pins to pinch inside. If you break these, the cannon will not stay telescoped.

References
  Physics Central © 2011
  A .gif image representing a vortex forming

Next Generation Science Standards
● K-5
  ○ PS2-1
  ○ PS3-3
  ○ PS4-1