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Air Zooka

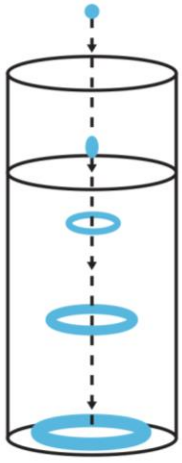
AIR-270

A Toroidal Vortex is whirling air or liquid in the shape of a doughnut. Vortices are created in nature by dolphins, volcanoes, tornadoes, hurricanes, and whirlpools. They can be created around the wings of an airplane, in the wake of a boat, or in a rocket blast. Now you can make Toroidal Vortices in your classroom with the Air Zooka. Use it to discuss friction, pressure, the Bernoulli Effect, or the Coandă Effect.

Classroom Activities

Activity 1: Simple Toroidal Vortices

Create a simple Toroidal Vortex with a droplet of food coloring and a tall glass of water. Start by holding the dropper about 3 cm above the water's surface. Squeeze a single drop of food coloring straight down into the glass. You will be amazed to see how the friction between the water and the food coloring will create the doughnut shaped rings!



See what happens when you drop the food coloring from different heights above the surface of the water. How does this affect the size of the ring formed or the speed of the ring as it moves through the water?

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When the drop of food coloring moves through the water, there is friction between the food coloring and the water (see Figure A). The sides of the food-coloring droplet get pushed upward as the food coloring continues to fall (see Figure B). This causes material from the bottom of the droplet to flow to the top, which results in a hole in the middle. A doughnut or Toroidal Vortex is formed. Figure C shows a cross sectional picture of the Toroidal Vortex as it moves down through the water.

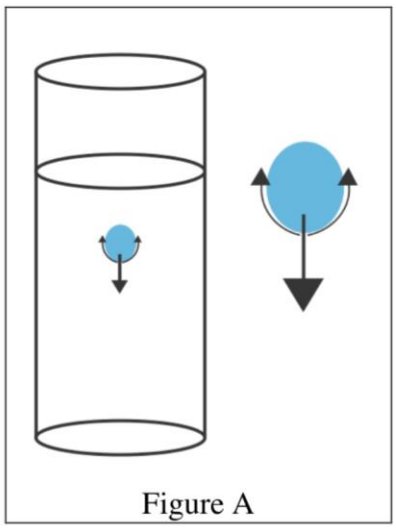


Figure A

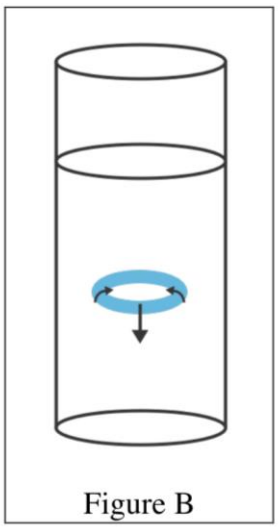


Figure B

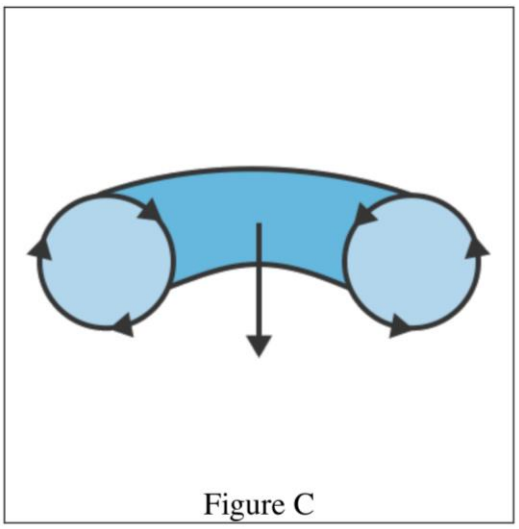


Figure C

Activity 2: Fog Rings

Use the Air Zooka to create Toroidal Vortices with fog or smoke.

1. Get out your Air Zooka, and ready a fog/smoke source. A cold fog, such as our Diffusion Mist (E. I. item number HS-7) seems to work best.
2. Pull back on the diaphragm in the Air Zooka and fill the chamber with fog.
3. Release the diaphragm to produce a fast moving pulse of air. Once the fog passes through the opening of the chamber, the outside stationary air slows down the airflow of the fog, similar to how the water slowed down the droplet in Activity 1.

If you fill your Air Zooka with plenty of fog, you can launch several rings.

What happens when you move the launcher forward while you launch the fog rings?

What happens when you move the launcher sideways or up and down while you launch the fog rings?

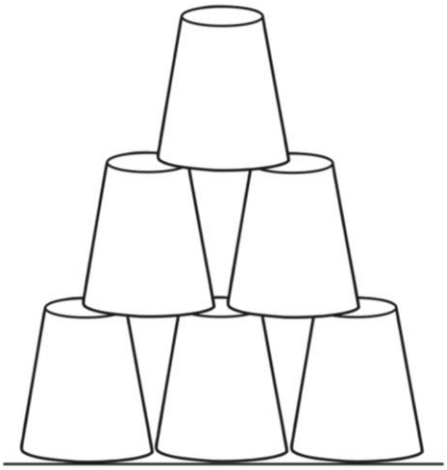
What happens to the fog rings if you try to fan them?

Activity 3: Blow 'Em Away

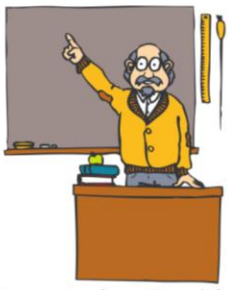
1. Grip the handle on the Air Zooka and aim at a target.
2. Grip the elastic air launcher with the other hand. Fully extend your arm and pull straight back (do not over pull).
3. Release the elastic air launcher to launch a powerful yet harmless ball of air!
4. Feel the Toroidal Vortices created by the Air Zooka!

Use the Air Zooka to blow out the birthday candles on your next birthday cake!

Use the Air Zooka instead of a softball to knock down the cups in the classic game below:



Air Zooka your teacher!



Air Zooka your students!

CAUTION: Do not aim the Air Zooka at a person's face or head!

Glossary of Terms

Bernoulli's Principle	The principle that the pressure in a fluid decreases as the speed of the fluid increases.
Coanda Effect	A streaming fluid tends to follow a nearby curved surface, if the curvature of the surface or the angle the surface makes with the stream is not too sharp.
Fluid	A nonsolid state of matter in which the atoms or molecules are free to move past each other, as in a gas or liquid.
Force	Any influence that tends to accelerate an object or change an object's state of motion; commonly, a push or pull.
Friction	The force that acts to resist the relative motion or attempted motion of materials which are in contact.
Pressure	Force per unit area.
Toroid (noun)	A ring-shaped surface generated by rotating a circle around an axis that does not intersect the circle.
Toroidal (adjective)	Doughnut-shaped.
Vortex	The shape of something rotating rapidly.

NGSS Correlations

Our Air Zooka and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

2-PS1-1
Students can use the Air Zooka Vortex Launcher to plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

3-PS2-2
Students can use the Air Zooka Vortex Launcher to make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

4-LS1-2
Students can the use the Air Zooka Vortex Launcher to develop a model to describe how animals receive types of information through their senses, process the information in their brain, and respond to the information in different ways.

5-PS1-1
Students can the use the Air Zooka Vortex Launcher to develop a model to describe that matter is made of particles too small to be seen.

5-PS1-3
Students can the use the Air Zooka Vortex Launcher to make observations and measurements to identify materials based on their properties.

Middle School

MS-PS1-4
Students can use the Air Zooka Vortex Launcher to develop a model that predicts and describes changes in particle motion.

MS-PS2-2
Students can use the Air Zooka Vortex Launcher to plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS4-2
Students can use the Air Zooka Vortex Launcher to develop and use a model to describe that waves are reflects, absorbed, or transmitted through various materials.

MS-LS1-8
Students can use the Air Zooka Vortex Launcher to gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

High School

HS-PS2-1
Students can use the Air Zooka Vortex Launcher to investigate and analyze data to support the claim that Newton's Second Law of Motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.