

The Smoking Ring aka The Air Vortex

The Big Idea

- 1) Air takes up space and has mass.
- 2) A blob of air moving through air results in an interesting donut shape that is demonstrated by the addition of smoke particles. This shape is caused by friction between the air particles.

Background

Air has mass and as it moves, it can displace other substances such as water or other air particles. When a blob of air moves through air, the other layers of the blob are slowed due to friction with the surrounding air. Therefore the central part of the blob moves faster. As the blob continues to move, the outer layers are continually dragged backwards and a swirling motion is created while the central portion moves straight ahead. The use of smoke particles reveals the outer layers of slower air swirling backwards while the central faster portion is clear. The resulting shape is a ring. Pipe or cigarette smokers can often create this vortex of air and smoke with their mouths and dolphins can create vortices of air through water.



Rock Hudson



Dolphin and
bubble ring

Materials

Demonstration - Airzooka

Airzooka and paper cup

Demonstration - Large vortex generator

Plastic garbage can vortex generator
Large flashlight
Fog machine

Vortex generators (per group)

Containers
1 square foot of plastic (from garbage bag)
Rubber bands
Scissors for cutting holes in containers

Procedure

To prepare before the session:

1. Warm up fog machine and fill machine with fog juice.
2. Cut required amount of plastic squares and draw circles on bottom of containers to cut out later.

During session

1. Ask the audience to describe air. Accept and work with all answers. ***Air is a mixture of gases – mostly nitrogen and oxygen. These gas molecules are constantly moving and can transmit energy (like sound) as well as force for air has mass.*** Demonstrate air exerting force with the Airzooka. Blast a few audience members (choose those that will have hair flying!) then demonstrate by knocking over a paper cup from a few feet away. ***These demonstrate that air has mass and is made of gas molecules that can move in unison.***
2. Bring out the Mega Vortex generator and blast a few people with that. Then add smoke so that the audience can see the “blob” of air moving through the room. This is easier to see with the lights dim and a flashlight shining on the resulting smoke ring as it travels through the air. ***Note: Quick and forceful bursts of air result in very fast moving vortices that are difficult to see. Try to create slower, fully created vortices, these are more impressive and easier to follow with the flashlight.*** Have some audience members try it out.
3. Explain the ring and swirling effect using the background information provided. Emphasizing that the smoke is caught up with the slower moving outer layer of air that is being dragged backwards. The center “blob” of air is still moving forward faster but the smoke is not highlighting it.
4. Ask the audience where else in their lives they see a vortex or vortices? Accept and work with all answers. And you can mention that they can study Fluid Dynamics in college.
 - Bubble ring from a dolphin or diver
 - Mushroom Cloud from explosion or volcanic eruption
 - Left [ventricle](#) of the [human heart](#) during cardiac relaxation ([diastole](#))

4. Now the families can make their own version of the vortex generator.
 - a. Hand out containers and have the adults cut a hole in the bottom with scissors. Poke a hole in center with a pencil then cute a circle or they can try a square or other shape.
 - b. Pass out plastic squares and rubberbands/tape to cover the large open side of the container.
 - c. Have the families fill their vortex generator with smoke and try to produce rings. A competition could be set up after some practice time for the longest sustained smoke rings.

Resources

Smoke rings

https://en.wikipedia.org/wiki/Air_vortex_cannon

<http://www.stevespanglerscience.com/experiment/00000076> How to make the large garbage can vortex generators.

<http://amasci.com/wing/smring.html> The science behind air vortices

<http://www.deeptune.net/deeptune/index.php?science09.php> The science behind water bubble rings

