

## Toroidal Tornado

### Overview

In this activity campers will create an air vortex cannon that propels rings of air.

Topic (s)	Biology, Physics
Grade Level	5-6
Cost (per class)	~\$5-10 (without demo) ~\$15 (with demo)
Time (preparation and activity)	30-60 minutes
Complexity	Easy-Medium

### Ontario Curriculum Links

#### Understanding Life Systems: Grade 6 - Biodiversity

- Because all living things are connected, maintaining diversity is critical to the health of the planet
- Humans make choices that can have an impact on biodiversity

#### Understanding Life Systems: Grade 7 - Interactions in the Environment

- Ecosystem are in a constant state of change. The changes may be caused by nature of by human intervention
- Human activities have the potential to alter the environment. Humans must be aware of these impacts and try to control them

#### Teaching Outcomes:

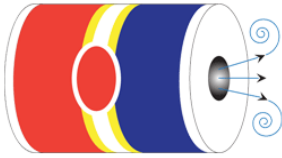
- Teach campers about poaching
  - Should be able to answer why poachers hunt illegal animals
- Teach campers about vortices
  - Should be able to briefly describe why water spins down the drain

### Theory & Background Information

- Why does water swirl down the drain?
  - As water is poured, it creates a slight directional spin
  - As water appears still, it is still slightly spinning
  - Vortex occurs due to the hole in the sink being smaller, and the water spinning faster closer to the opening than further away
  - Can be demonstrated by spinning water in a circular sink, by stirring the water, letting it sit, then draining (drains the direction that it was stirred)
- Vortex ring (Toroidal vortex) - particles moving in a roughly circular path around an imaginary circle/core - Like a doughnut
  - Toroid - doughnut (O) shaped
- How it works

## Toroidal Tornado

- Air is pushed out of an opening, displaces the air in the centre, surrounding air swirls
- Occurs due to the air closest to the core having a higher angular velocity than the air further away (creates a swirling effect)
  - Angular velocity - How fast an object rotates around a fixed centre (how fast you can go around the perimeter of a circle)



- Poaching - illegal hunting and capturing of wild animals
  - Hunting animals for their resources (such as elephant tusks, or animal fur)
  - Destroys populations
  - Tampers with natural balance of environment/ecosystem

### Delivery Analogy:

- The spinning water in a drain is like a figure skater spinning
  - When her arms are out, she spins slowly, but as she brings her arms in (closer to centre) she spins faster, just like how water spins fastest when closest (at the drain) than further away (top of sink/tub/etc)

### Per Camper:

- One plastic cup - Solo Cups
- Approximately a foot of tape (coloured looks best)
- Scissors
- Square made of garbage bag (Large enough to fit over top of cup)
  - About 10x10cm

### Per Camp:

- Candles or styrofoam cups (light targets)
- Smoke machine (optional)
- For large demo
  - Garbage bin
  - Garbage bag or shower curtain
  - Bungee cord
  - Cutting device for garbage bin
- Paper (for cutouts)

### Preventative

1. Make sure to let campers know not to point it at anyone else. It's not necessarily dangerous as it is air, but it is irritating.
2. Have a window or door open if using the smoke machine, as it can fill up the room (if using smoke machine)

## Toroidal Tornado

### Reactive

1. Air cannons may need to be taken away from campers, or have them keep it in their bags if misused.

### Procedure

#### Preparations

1. Making a sample version, or even a larger version is very helpful as a model finished product
2. Set up your smoke machine (optional to use)
3. Can also create small cutouts to knock over out of paper

### Introduction

1. Ask if anyone has watched the water drain out of a sink/tub/toilet
  - a. Have them explain how it drains (twists around, like a tornado)
2. Explain why this occurs
3. Explain the circular (toroidal) vortex
4. Ask the campers what they know about poachers - Can brainstorm on board
  - a. Make sure to include why they do it

### Activity

1. Explain that we are going to create a device that uses both toroidal vortices, and stops poaching, without harming them
2. Show the example cannon that you have created, say how it is to prevent poachers
3. Explain before they start that it is not a weapon, just used to divert poachers, should not be pointed at each other
4. Hand out materials
5. Cut a circular hole in the bottom of the cup, a few centimetres in diameter
6. Cover the top of the cup with the garbage bag piece
7. One person holds the bag over with little slack, the other person tapes it to the cup
8. Tape a handle on top of the garbage bag by folding tape in half and sticking it on top
9. Let campers test their cannon with some of the smoke inside of their cannon, to show the smoke rings (if using smoke machine)

### Resources

<http://www.physicscentral.com/experiment/physicsathome/cannon.cfm>  
[http://www.aces.edu/waterquality/faq/faq\\_results.php3?rowid=668](http://www.aces.edu/waterquality/faq/faq_results.php3?rowid=668)