

## Heron's Fountain

**Lesson Type:** Engineering

**Target Grade:** Elementary/High School

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### Brief Overview

The goal of this lesson is to teach students about pressure and potential and kinetic energy

### Teaching Goals

- Air Pressure,  $PV = nRT$
- Potential and kinetic energy

### Agenda

- Intro to Heron's Fountain (5 min)
- Teach students how to build the fountain and have them build one each (30 min)
- Ask students to predict what will happen when water is added
- Explain how Heron's Fountain works
- Discuss improvements to design
- If time permits, allow students to make adjustments and see who can make longest lasting fountain or highest fountain

### Lesson Introduction

- Information about the lesson that you want to state or teach before running the modules
- Don't need to include if you don't need to have an introductory lecture

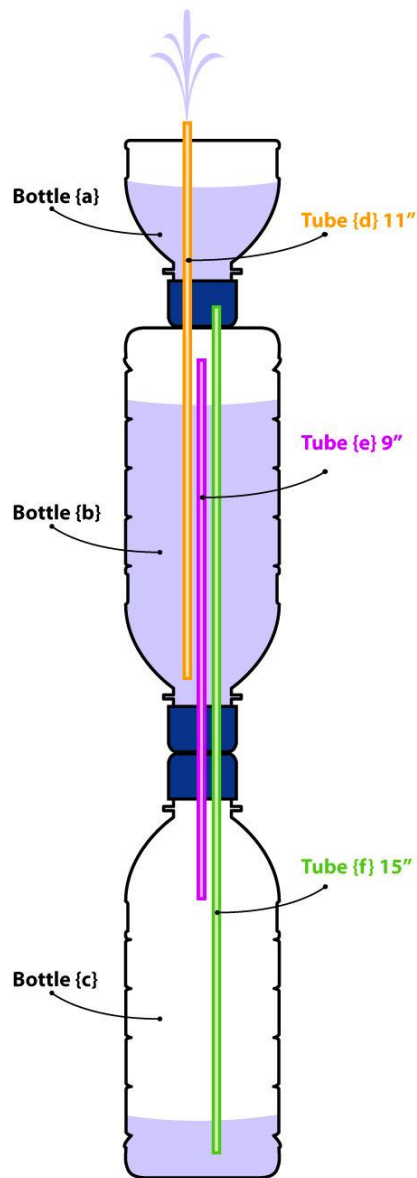
Material	Amount per Group
3 16.9 fl oz plastic bottles	3 per student
Clay/play-doh for sealing	1-2 jars per site depending on site size

3/16" thin wall rigid tubing cut into 9", 11", and 15" pieces	1 per student
Scissors	

5/32" drill bit	*to be done in advanced
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### Material to Teach

- Explain what this module is supposed to show/prove and the science behind it



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### Procedure for each Module

- Note: If possible, holes should be drilled into bottle caps in advanced and tubing can be pre-cut into proper lengths to save time.

- Use a 5/32" drill bit to drill two holes into each cap making sure the holes in the three caps line up with each other. Use one of the drilled caps as a guide to drill two holes in the bottom of one of the plastic bottles.
- Cut another bottle (without holes in the bottom) in half
- Connect the three bottles with the plastic tubing in accordance with the diagram above.
  - The 11" tube connects the top two bottles (half bottle and bottle with drill), the 9" connects the bottom two bottles, and the 15" will connect all three bottles.
- Fill the middle bottle with water and screw the bottles together. Seal any leaks with clay.
- Start the fountain by filling up the leftover bottom half of the water bottle with water and pouring it into the top.

### Notes for Mentors

- The easiest way to explain Heron's Fountain to students is to draw out the diagram first and then refer back to with the explanation.
  - Water from bottle A travels down the 15" tube leading down to empty bottle C
  - As water trickles down into bottle C, the pressure in the bottle increases forcing air up into bottle B through the 9" tube
  - As air travels up into bottle B, the pressure in bottle B increases and forces the water up the 11" tube
- For middle and high school, introduce the idea of potential and kinetic energy.
  - Height the water falls is greater than the height it travels up
  - Perpetual motion machines? Can Heron's Fountain operate continuously?
    - No, since no water enters bottle B, once all the water from bottle B is pumped out, the fountain will stop working
    - Discuss ways to extend length of time of operation, height of fountain

### References

- <http://blog.makezine.com/2008/06/08/build-herons-fountain-1/>

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### Summary Materials Table

- For Logistics' convenience, have a summary materials table for each modules at the very end of the lesson on a separate page
- Make sure to include a vendor link or picture to ensure that logistics buys exactly what you want

Material	Amount per Group	Expected \$\$	Vendor (or online link)
3 16.9 fl oz plastic bottles	3 per student	\$10/box	
Clay/play-doh for sealing	1-2 jars per site depending on site		

	size		
3/16" thin wall rigid tubing cut into 9", 11", and 15" pieces	1 per student		
Scissors			
5/32" drill bit	*to be done in advanced		