

Nonstop Fountain

Up, up, up the water goes! Understand the principles of fluid dynamics and hydraulic engineering to create your own water bottle fountain. You may be surprised to discover how much space air actually takes up!

TEKS:

SCI 4.6 A: The student is expected to differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.

SCI 4.7 C: The student is expected to identify and classify Earth's renewable resources, including air, plants, water, and animals; and nonrenewable resources, including coal, oil, and natural gas; and the importance of conservation.

SCI 5.6 A: The student is expected to explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy.

SCI 5.7 C: The student is expected to identify alternative energy resources such as wind, solar, hydroelectric, geothermal, and biofuels.

Materials:

- Hot glue
- Permanent marker
- 3 plastic water bottles with caps
- Power drill
- Scissors
- 4-6 thin plastic straws or coffee stirrers
- Water

How To:

Part 1: Prepare the bottles, caps, and straws

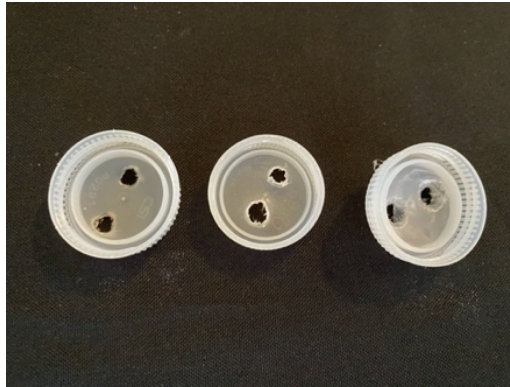
1. Label your first water bottle "1," the second bottle "2," and the third bottle "3," so that you can keep track of them as you build your fountain.
2. Use scissors to cut water bottle 3 in half. Set it aside.

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- Find a drill bit that will make a hole that is slightly larger than the diameter of your straws. Use this drill bit throughout the next steps.
- Drill two holes in the cap of water bottle 3. Use this cap as a guide to drill two holes in the caps of water bottles 1 and 2, so that all three caps have two holes drilled in the same location. **Safety: an adult should assist when using a power drill.**



- Use hot glue to secure one of the caps to the bottom of water bottle 2. Drill two holes in the bottom of water bottle 2, using the cap as a guide. Set this bottle aside for now. **Safety: an adult should assist when using a hot glue gun.**



- Cut a small slit at the end of one straw. Place the straw with the slit onto the end of a second straw so that they overlap approximately one inch, and use hot glue to secure in place. Use this procedure to create a straw that is approximately the length of two water bottles (straw 1), and two straws that are approximately the length of one water bottle (straws 2 and 3).



- At this point, you are ready to construct your fountain!

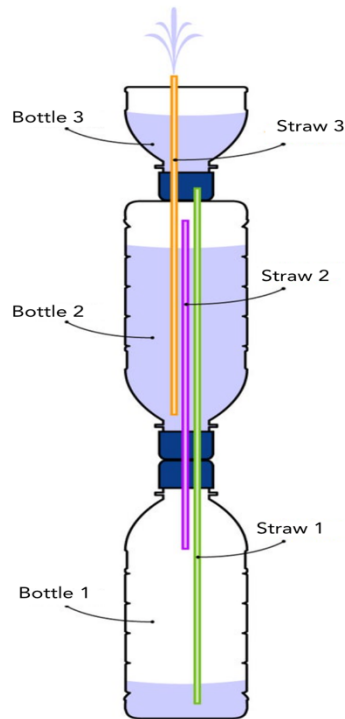
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Part 2: Assemble the fountain*

*Use the diagram below to assist with construction. In this diagram the green straw = straw 1, purple straw = straw 2, and orange straw = straw 3.



1. First, use hot glue to attach two caps back-to-back, with their pre-drilled holes aligned. If needed, re-drill the holes after the glue dries.



2. Screw the back-to-back caps onto bottle 1.
3. Place straw 1 through one of the holes in the back-to-back caps. Adjust straw 1 so that it is approximately half an inch from the bottom of bottle 1 and hot glue it in place on the cap.
4. Put straw 2 through the second hole on the back-to-back caps and adjust the straw so that it extends approximately half an inch into bottle 1. Secure this straw in place with hot glue. Make sure that the back-to-back cap is airtight by adding more hot glue, if needed.

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5. Screw bottle 2 onto the back-to-back caps, cutting straw 2 so that it ends just below the base of bottle 2.
6. Adjust straw 1 so that it goes through one of the holes that you drilled in the cap on bottle 2 and secure in place with hot glue.
7. Place straw 3 through the second hole in bottle 2. Adjust straw 3 so that it is approximately half an inch from the back-to-back caps and hot glue it in place on the cap.



8. Screw the top half of water bottle 3 onto this final cap. Cut straw 1 so that only half an inch sticks out into bottle 3. Cut straw 3 so that approximately two inches stick out into bottle 3. This is the top of the fountain!



Part 3: Add water and watch the fountain work!

1. To make your fountain work, first pour water into bottle 3. This water will run through straw 1 into bottle 1.
2. Once bottle 1 is full of water, turn the entire fountain upside-down so that the water from bottle 1 runs through straw 2 into bottle 2.
3. Once bottle 2 is full, turn the fountain back over.
4. Now, pour water into the top of bottle 3 again. This should start the fountain!

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STEM Explanation:

The fountain you just created out of water bottles and straws is known as a Heron's Fountain, named after the Greek inventor, Heron of Alexandria. A Heron's Fountain is a hydraulic machine that uses concepts of fluid dynamics such as gravity and air pressure to create a water spout. How does your "Nonstop" Heron's Fountain work?

All Heron's Fountains have three parts: a water basin, water supply, and air supply. Bottle 3 was your water basin, bottle 2 the water supply, and bottle 1 the air supply. When you turned the fountain back over in Part 3, Step 3, the water in bottle 2 in the middle of the fountain acted as your water supply. This also allowed for bottle 1 to act as the fountain's air supply. Then, when you poured water into the top of bottle 3 (the water basin) gravity caused it to travel through straw 1 into bottle 1. The addition of water into bottle 1 displaced some of the air supply and forced this air into bottle 2 through straw 2. The addition of air into bottle 2 increased the pressure in bottle 2 and forced water up through straw 3. This pressure caused water to spray out of the top of the fountain! You probably found that this fountain was not actually "nonstop" and did not work forever. A Heron's Fountain will continue to work until either the water level in bottle 1 rises higher than straw 2 (preventing air from moving into bottle 2), or until the water supply level in bottle 2 falls below straw 3.

Career Connection:

Hydraulic engineers work with principles of fluid mechanics to solve problems related to the collection, storage, control, transport, regulation, measurement, and use of water. Almost every industry uses hydraulics to perform various tasks, from compressing garbage to powering roller coasters to enabling brakes in cars and airplanes.

Resources:

https://www.youtube.com/watch?v=K49QOM_B8dA&ab_channel=DaveHax

<http://www.arvindguptatoys.com/toys/Turbinesprinkler.html>

https://www.ducksters.com/science/environment/wind_power.php

<https://www.instructables.com/Recreate-Herons-fountain-from-water-bottles/>

https://chphysics.weebly.com/uploads/1/5/8/1/15817496/herons_fountain.pdf

Image Source:

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