

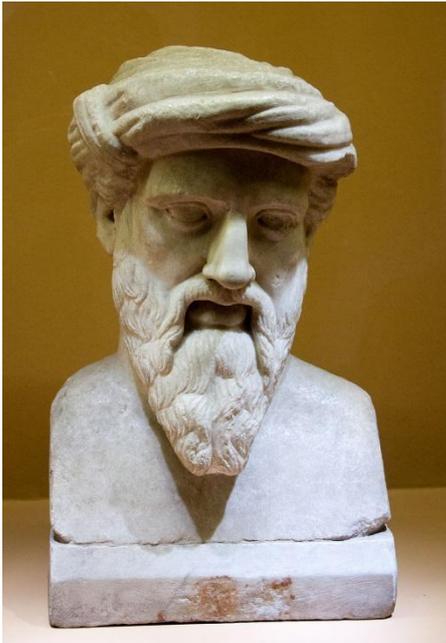
The Physics of Liquids

Respective blueprint	The Pythagorean Cup
Description	<p>In this pedagogical sequence students will learn the properties of water, and pressure using the Pythagorean cup.</p>
Learning Objectives	<p>Students will:</p> <ul style="list-style-type: none"> - Learn how to create a Pythagorean cup - Understand the theorem of Pythagoras - Be able to create a syphon

<p>Related curricular subject(s)</p>	<p>Physics, History</p>
<p>Prerequisites / preparatory actions for teachers</p>	<p>Teachers should gather the materials for the blueprint</p>
<p>Prerequisites / preparatory actions for students</p>	<p>Understand the basics of physics, know how to use and create a syphon effect. Have basic knowledge on the theorem of Pythagoras.</p>
<p>Age of students</p>	<p>12-15</p>
<p>Duration</p>	<p>2-3 hours</p>
<p>Level of difficulty</p>	<p>Intermediate</p>

Step by step description of the tasks

Step 1: Who is Pythagoras?



¹The teacher introduces Pythagoras to the class.

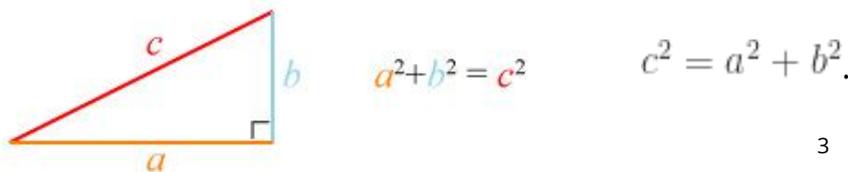
Pythagoras of Samos (c. 570 – c. 495 BC, Ancient Greek: Πυθαγόρας ὁ Σάμιος) is the father of Pythagoreanism. He was also a famous ancient Greek philosopher. He was famous in ancient Greece for his political and religious teachings. He was a big influence on the philosophies of Plato, Aristotle, and, in consequence, Western philosophy.

Pythagoras was credited with many mathematical and scientific discoveries during antiquity. Among those: the Pythagorean theorem, the spherical nature of the Earth, the division of the earth into 5 climate zones, the Theory of Proportions, etc. Word is that he is the first to call himself a “philosopher” (literally a “lover of wisdom”). There is a debate whether Pythagoras made these discoveries. Many of his attributed accomplishments were probably made earlier, or by his colleagues or successors and the extent of his contribution to mathematics or natural philosophy is debated.²

Step 2: Small reminder of Pythagoras' theorem

The “Pythagoras cup” gets its name because its invention is credited to Pythagoras of Samos, best known for the Pythagorean theorem, which states that:

“For a right triangle, the square of the hypotenuse is equal to the sum of the squares of the two lesser sides, i.e.”



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The teacher explains or reminds of Pythagoras' theorem.

Step 3: Introduce the Pythagorean cup

What else did he invent? According to the lore, Pythagoras was at the water supply works on Samos. As he was supervising workers, he invented the “greedy cup” to try to diminish the amount of wine drunk by the workers. If they filled their cups up to a reasonable level, they could drink at ease. If they were too greedy, the cup would empty itself

¹ Image Source: By Unknown author - Photo by Szilas, 2013-03-04, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=36520519>

² Pythagoras. (2001, July 20). Wikipedia, the free encyclopedia. Retrieved January 14, 2022, from <https://en.wikipedia.org/wiki/Pythagoras>

³ *Physics demonstrations: The Pythagoras cup*. (2012, April 26). Skulls in the Stars. <https://skullsinthestars.com/2012/04/26/physics-demonstrations-the-pythagoras-cup/>

completely through the bottom. While this is a fun anecdote, there is no proof that it really happened like that, but people can still find beautifully decorated Pythagoras cups as souvenirs on Samos today.⁴

Step 4: Make the students brainstorm ideas on how the cup may work.

So how does it work? First, make a brainstorming session with the students to try and understand how the cup may work. Let them observe a Pythagorean cup in class if possible and make a demonstration to them of the cup working. If not possible to have a cup in class, show the students some videos of a Pythagorean cup working. After hearing their thoughts, you may show them this image of a cup being cut in half and let them offer some more propositions.



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Step 5: Explain and/or build the Pythagorean Cup

The teacher explains the Pythagorean cup's mechanism. As you can see, the center of the cup is raised, and a tube goes down through the bottom of the cup. This tube is covered by a roundish cap and a small hole at the foot of this cap lets the water flow.

⁴ *Op.Cit.*

⁵ Wikimedia Commons, the free media repository. (2017, August 13). *Pythagorean cup cross section.jpg* [Cross section of a Pythagorean cup displayed at a shop in Samos (Greece)]. commons.wikimedia. https://commons.wikimedia.org/wiki/File:Pythagorean_cup_cross_section.jpg

You may direct the students to search for more information online. If the teacher wants, they can use the blueprint to build a Pythagorean cup with the students.

Step 6: Presenting the science behind the experiment

The teacher should explain the principles of liquids mechanics, gravity and atmospheric pressure that are involved in the inner workings of a Pythagorean Cup.

According to Pascal's law, which states that “The pressure exerted anywhere upon an enclosed liquid is transmitted undiminished, in all directions, to the interior of the container.”,⁶ the level of water in communicating containers will always be the same, finding its level. By filling the cup above the siphon part of the cup, the water is pushed over the top curve of the siphon and falls down the drain, pulled by gravity, pushing the air present in it out. This creates a draw of air that continues to pull the water up in the siphon and down the drain where gravity continues to pull it down until no water is in contact with the hole at the base of the siphon inside of the cup.

Step 7: Finding other occurrences of this same principle in everyday life

The teacher should ask the pupils if they can think of any other objects that could be benefitting of the same principle as a Pythagorean cup, then he can explain a few of these other examples.

⁶ *Basic hydraulic theory | Cross Mfg.* (n.d.). Cross MFG. <https://crossmfg.com/resources/technical-and-terminology/basic-hydraulic-theory>

For example, this principle can also be used in piping a house, especially toilets. It is what is used when you need to syphon a container, be it a car gas tank, a fish tank to change the water, etc...

Conclusion

In this lesson the students learn about the use of syphons and Pythagoras' theorem. They learn how they were used in ancient Greece and they can use them to do some of our everyday tasks.

Assessment activities

Activity 1. Find information about Pythagoras' works and present them to the class.

Activity 2. Search for information on how Pythagoras found his Theorem.

Activity 3. Try to imagine another way to use the principle of the cup. Present your thought process to the class: hypothesis, verification, conclusion.