

Justice Cup: A Real- World Physics Demonstration

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| **Introduction** | |
| The Justice Cup is an ancient invention that used a clever trick to represent a deeper meaning: the endless desire of human beings. This clever cup demonstrates the concepts of potential energy, gravity, and surface tension. using both play and insightful engineering. This lesson plan will explore the mechanisms of the justice cups as a way to understand potential energy and siphons.  Using play, hands on demonstrations, and critical thinking, students will see physics present in the real world. | |
| **Indiana Standards Connections:**    (7th Grade) MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system | **Compelling Question(s):**  How do siphons use potential energy?  How does gravity influence potential energy?  What other forces impact potential energy? |
| **Lesson Objectives:**  Students will be able to name the components of a siphon (an object used everywhere in their daily lives!)  Students will be able to explain the way potential energy works within the Justice Cup | |
| **Materials** | |
| 1. Justice Cup on Window the World site: <https://w2w.indiana.edu/explore-collections/justice-cup.html> 2. Materials to make demonstration of justice cup: <https://www.youtube.com/watch?v=SdRdEZcawSc> (this video provides a great tutorial) 3. This video explains how a Pythagoras cup works: <https://www.youtube.com/watch?v=A-YMHXuiaWw> (it is very similar to the justice cup, but you will need to make a slight adjustment to how you explain it) 4. This video explains siphons clearly: https://www.youtube.com/watch?v=LmsIYwf8QqQ | |
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| **Activities**   1. Review the basics of potential energy with students. Tell students you are going to look at an object that uses potential energy in interesting ways. 2. Show students the justice cup—let them examine it for a little bit. You could also show students images of a Pythagoras cup that uses the same principles. 3. Explain the lore behind this cup: This is a normal drinking cup, unless it is filled all the way to the top. Then, all the liquid is drained into the base and the "greedy" pourer gets no drink at all. This vessel symbolized the endless desires of human beings. Duke Huan of Qi kept it by his side as a reminder to be cautious of these desires and to maintain a peaceful mind. If a drinker only poured a small amount into their cup, nothing would happen. But if they poured their glass full, the entire cup would empty. 4. Ask students how this might work? Let them brainstorm together. It may be helpful to provide a diagram of the inside of the cup.   undefined   1. Explain what siphons are, how they allow water to flow uphill without a pump! Toilets are a very common example of this. Watch the video (https://www.youtube.com/watch?v=A-YMHXuiaWw) with students and then explain a little more in detail. Here is a possible explanation to help students understand:   The siphon is created due to the interplay between gravity and hydrostatic pressure. Water tends to flow from areas of high pressure to areas of low pressure. When the liquid level rises such that it fills the U-shaped chamber, the liquid will start to fall due to gravity. As gravity pulls the water column down the pipe of the Pythagorean cup, the lower pressure thus created on the other end causes the liquid to be overpowered, subsequently allowing itself to be “dragged” along, stopping only when the water level either falls below the intake or the outlet. Some modern toilets operate on the same principle: when the water level in the bowl rises high enough, a siphon is created, flushing the toilet.   1. Watch this video with students. https://www.youtube.com/watch?v=LmsIYwf8QqQ. Stop to discuss where potential energy is the highest. Discuss how gravity and surface tension make the liquid behave in ways that on the surface seems contradictory. 2. Let students discuss to figure out how the the principals happening in step 6 apply to the justice cup. | |
| **Assessment Suggestions**  You could have students make their own demonstration video of how the justice cup works. This could either be done with visual drawings, or you could provide students with their own materials to create their justice cup. Ask them to include principles of potential energy in their demonstration. | |
| **Extensions**  Ask students to learn the mechanics behind another everyday object they don’t understand (a bike, pulleys, a vacuum, a roller coaster, etc.). They could create a small demonstration or a YouTube video to explain their findings. | |

Activity Possibilities

Some of the best opportunities for education are *integrative*—meaning that students are able to make connections across disciplines to reinforce the knowledge that they are developing. For example, they may be learning about Renaissance Italy in World Studies at the same time that they read Dante’s *Inferno* in English class while also studying Botticelli in Art. Feel free to combine and adapt some of the ideas across disciplines and standards to best suit your particular context. You can also collaborate with other teachers at your school or supplement the resources provided by contacting your librarian.

**Note: The following ideas are meant to give general guidance for teachers to include artifacts and other material culture in their classrooms. They are not meant to be treated as comprehensive activities or lessons that are one-size-fits-all for any classroom. They should be personalized to best fit the needs of a teacher’s individual context in accordance with prior student learning, student abilities, available resources, and any curriculum.**

**Art**

**Visual Arts – Responding:**

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| Anchor Standard 7: Perceive and analyze artistic work  Enduring Understanding: Individual aesthetic and empathetic awareness developed throughout engagement with art can lead to understanding and appreciation of self, others, the natural world, and constructed environments.  Essential Question(s): How do life experiences influence the way you relate to art? How does this artifact reveal what is valued in culture? What can we learn from our responses to art? | |
| VA:Re7.1.1a | *Select and describe works of art that illustrate daily life experiences.* |
| VA:Re7.1.3a | *Speculate about processes an artist uses to create a work of art.* |
| VA:Re7.1.6a | *Identify and interpret works of art or design that reveal how people live around the world and what they value.* |

*Art comes from many different contexts. Sometimes it is a necessity and everyday objects like maps and quilts become art artifacts. At other times, it is those who have the time to ponder and create who are the voices that are heard loudest in art. Ask students to consider the cultural values this artifact communicates. It may be interesting to discuss what type of person has the time and resources to create a cup like this? How do ease and leisure contribute to the creation of art?*

**Math**

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| C.AI.6 | *Use definite integrals to find the volume of a solid with known cross-sectional area.* |
| 8.GM.2 | *Solve real-world and other mathematical problems involving volume of cones, spheres, and pyramids and surface area of spheres. (E)* |

*Making space for play in learning can help students feel creative and curious in the classroom. The Justice Cup is an interesting, real-world object that investigates volume in interesting ways. Based on the level of your students you could ask them to calculate the volume of liquid the cup can hold before overflowing. For more complex problems, you could ask calculus students to calculate the volume of the inner tube of the cup.*