Resonance Bowl

P7-7510

INSTRUCTIONAL GUIDE

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Background

The Resonance Bowl can be traced back to ancient Tao tradition in China during the Han Dynasty (202BC – AD9). It is referred to by many names such as the “Bronze Dancing Water Basin”, “Chinese Fish Basin”, “Jumping Water Basin” and the “Chinese Singing Fountain Bowl”. Made from a bronze alloy from a foundry on the outskirts of Beijing, it was used in the early Tao Temples for the purpose of meditation and was said to be a toy for the upper class. According to the foundry that produces the bowl, it will stimulate your mind, maximize all essential muscles and offer much happiness and long life to whomever uses it.

Introduction

At FOUR points around the rim, the water surface will begin to ripple, first lightly, then vigorously. Soon water droplets will shoot up from these areas of disturbance, quickly becoming continuous streams, like tiny fountain jets. The water droplets grow into dancing droplets and finally spouting jets with each rub of the handle. At a maximum, the spouts can reach 30-50 cm or so above the water surface. Interestingly, the bowl is cast with a design of four fish inside, their tails directed toward the center of the bowl and their mouths pointing towards the rim. Somehow, at the Beijing Foundry, the bowl is cast so that the four dancing spouts emanate from the mouths of the fish!

Instructions:

1. Place the bowl on a surface that is firm, but allows the bowl to vibrate. The skid-resistant mat that is included can be used to place the Resonance Bowl on so that the user gets all the vibrational energy that is put into the bowl.
2. Fill the Resonance Bowl about halfway with clean water. You can experiment with different levels of water, but with a bowl ½ full, the desired effect is enhanced.
3. Wash your hands with soap as if you’re going into surgery (don’t touch anything else prior to touching the handles of the Resonance Bowl), being absolutely certain that your hands are completely free of any oils. You will NOT be able to achieve any effect with the bowl with even the smallest amount of oil or lotion on your hands. Also, it is suggested to clean the handles of the bowls thoroughly with isopropyl alcohol. (This is especially important before using it the first time.)

You can also improve the effect by shining up the handles with brass wool before you use it from year to year.

4. Moisten your hands slightly by dipping your palms into the water and begin to rub your hands back and forth IN RYTHYM in opposite directions on the brass handles. I have found that you can also rub the handles IN RYTHYM together as well for a similar result. You should have that "squeaky-clean" feeling where your hands meet the handles. Make long, steady strokes using your whole hand, from the tips of your fingers to the heels of your palm. You need to apply a slight amount of downward pressure as you rub the handles. A light touch seems to work better than a forced, heavy-handed approach.

Concepts

What's Going on?

The vibration of the handles, in turn, increases the vibrations of the bowl, causing the bowl to vibrate; in Physics, we call this resonance, where one vibrational frequency causes the natural vibrational frequency of another object to increase. The vibration causes two phenomena to occur:

a. The bowl will create a sound, depending on its size (~196 Hz for a "big" bowl and ~330 Hz for a "medium-sized" bowl).

b. In addition, standing waves are created in the water illustrating an interference pattern called a Chladni pattern. Standing waves are produced by the addition of two identical waves traveling simultaneously in opposite directions through any elastic medium. These waves will constructively and destructively interfere with each other as they pass one another. The resulting wave from the addition of these two waves will form a standing wave in the metal rim. The standing wave that is produced sets up FOUR areas of maximum vibration called antinodes, the areas in the water that "spout" and cause the water droplets to jump off the surface. There are also FOUR areas where minimum vibration occurs and these are known as nodes. With practice, you should be able to create four antinodes along the entire rim of the bowl that are so strong that the water will spray out of the bowl. This occurs where the artist intentionally engraved the four fish mouths.

Experiments

1. If the bowl is touched firmly at any of the anti-nodal positions, the finger will absorb the vibrational energy, and the waves will be reduced or totally stopped. This effect is called dampening. However, if the bowl rim is touched at any nodal area, there will be little energy lost since the node has minimal vibrational energy and the spouting should continue as before.
2. By varying the amount of water in the bowl, you can investigate with your student what might be the optimal water level for maximum effect and have them explain why. Is it easier or more difficult to create the standing waves with different water levels?
3. By rubbing harder and faster, you can cause the bowl to produce a high-pitched squeak. When it does, you can sometimes create additional nodal and anti-nodal points in the water.
4. Try floating a cork in the water while playing with the Resonance Bowl. Observe its movements.
5. You can also place a small amount of sand in the bottom of the bowl (…instead of water) and observe how the vibrations move the sand.

Advanced Physics with the Resonance Bowl

Your hands are creating vibrations in the handles from the adhesion of your wet skin to the brass. As your hands move, this adhesion creates a tension in the skin of your palms, and when this exceeds the frictional forces, your skin will slide, reducing tension. If your hands are in constant motion, your skin will vibrate the handles as it repeatedly sticks and slides. This “Sticking and Sliding” phenomenon is similar to squeaking chalk on a chalkboard, the skidding of tires on pavement or a sneaker squeaking on a gym floor. The vibrating handles will then create transverse mechanical waves to travel outward from the handle along the metal rim of the bowl in BOTH directions. The metal rim acts as an elastic medium to transmit these waves. If the circumference distance around the rim from handle to handle is EQUAL to a multiple of a half wavelength, then standing waves will be produced. It is easy to create a mechanical wave in the rim with a wavelength exactly equal to the length along the rim from handle to handle. The handles AND the midpoint along the rim BETWEEN the handles will experience minimal vibrations (nodes). There will be four positions around the rim that are nodes, and another four positions that are antinodes. The antinodes will be formed at ¼ and ¾ arc lengths from handle to handle. Nodes will appear at ½ the arc length between handles AND at the handle positions. These positions will be regularly spaced and easily observed from the ripples and disturbances in the water along the edges of the bowl.

More Experiments with the Resonance Bowl

Students love to try the Resonance Bowl and it is surprising to see who is the most successful. Sometimes it is the unsuspecting quiet student who is able to resonate the bowl to its maximum effect. Resonance Bowl is a great example of the creation of standing waves in solids; most of the standing waves that students produce in class are with springs or occasionally a teacher with have an old set of Chladni plates that he/she might use to demonstrate the standing wave interference patterns with a violin bow and sprinkled salt on its surface. The Resonance Bowl demonstrates the same phenomenon but with water instead of salt. “YouTube” provides many videos on Chladni plates and the Resonance Bowl and how to use it properly. Make sure you dry the bowl after its use so that no rust spots form in the bowl, although those will not affect its performance.

Related Products

Mini Ripple Tank (PA-8638) The Mini Ripple Tank provides a simple and effective method to investigate the properties of waves. The tank has settings that allow you to adjust the wave frequency and the frequency of the strobe light showing a broad range of wave patterns.

Singing Rods (Set of 2) (P7-7250) A must for explorations of sound and waves, these rods are an easy way to demonstrate longitudinal waves as opposed to transverse waves. They're ideal for teaching about nodes and anti-nodes in standing waves.

Sound Wave Interference Kit (P7-7600) Now you can get a complete economical solution for demonstrating wave interference on a classroom size scale. Kit includes signal generator and powered speakers, everything you need for this great demonstration.

Acknowledgements

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He continues to promote learning science through demonstrations, music, humor and real-life scenarios.