23. Upside-NMOG

Report

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Contents

Problem to be investigated

Upside Down: A glass filled with water and covered with a paper card can be turned upside down. What minimum amount of water in the glass is required for this trick?

INTRODUCTION

If the cup is fully filled, the compressibility of water is much greater than that of the air, also the surface tension of the water keeps the air out of the cup. So the water is held in the cup.

But what happens if the glass is not fully filled?

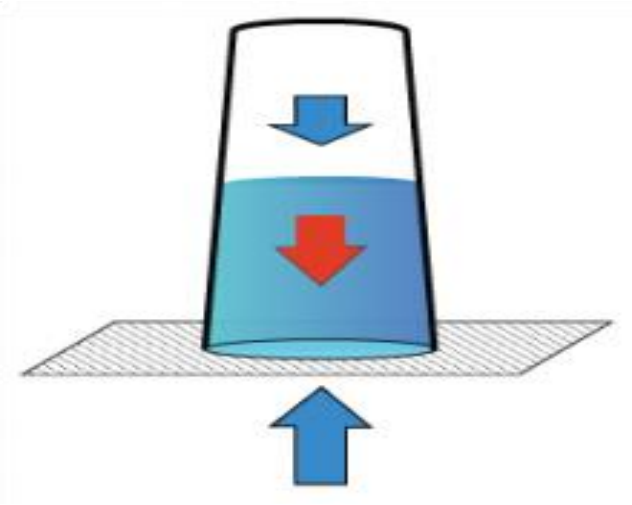
Little amount of water

Actually even with little amount of water, as long as it covers the open of the cup and the cardboard on it, the water stays in the cup.

Although the compressibility of water is much smaller, the air inside the cup provides enough compressibility in order to stay intact.

Atmospheric Pressure

Atmospheric pressure is caused by air gravity and air molecules movement, air pressure in the half filled upside-down cup is lower than the air pressure outside due to less gravity, so the air pressure can still hold the water in half filled cup.



LEAKS

- So when you turn it over, in order for the water to leak out, the cardboard would have to move a small amount away from the edge of the cup, which it cannot do without expanding the water slightly, which the incompressibility of the water does not allow.
- So if the seal around the edge of the cup is good, you cannot move the cardboard without reducing the pressure in the cup, and the air pressure outside is not being reduced, so the air pressure outside holds it in place.

Cohesion

It is easy to see that the drop seems to have a "skin" holding it into a sort of flattened sphere. It turns out that this *surface tension* is the result of the tendency of water molecules to attract one another (called *cohesion*). The lowest energy state for this drop occurs when the maximum number of water molecules are surrounded on all sides by other water molecules -- meaning that the drop should have the minimum possible surface area, which is a sphere. The effect of gravity flattens this ideal sphere into the shape we see.

Shape of the glass

Does it matter?

- Only to a small extent. A glass that is tapered, with the base smaller than the mouth, is easier than a bottle with a narrow mouth and a wide base.
- The reason for this is that in the case of the bottle, the card has to sag by a bigger amount in order to generate the necessary volume (and pressure) change.
- If the card sags too much, it is likely that some water will dribble out the crack on one side and some air will bubble in on the other, and the balance will become unstable.

EXPERIMENT

HYPOTHESIS

The experiment will be successful only when the water is enough to fill the whole area of the paper inside the glass.

EXPERIMENTAL PROCEDURE

- Pour water in a cup from 50ml and descending.
- Put an index card over the mouth of the glass and press the palm of your hand on the index card, pressing the card against the rim of the glass and depressing it slightly into the glass in the center.
- While your hand is on the index card over the mouth of the cup, invert it and slowly take your hand away.
- If you hold the cup steady and level, the water should remain in the glass

Equipment

The total surface of the the cup was 38,425

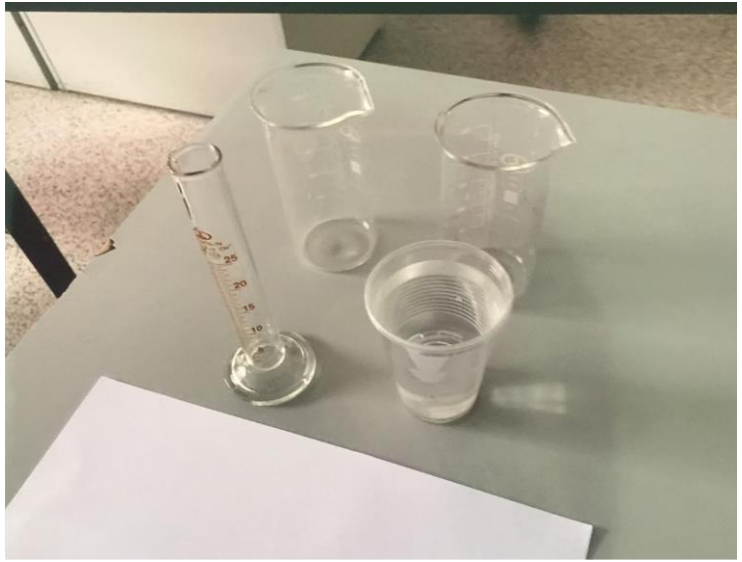
The diameter was 7 cm

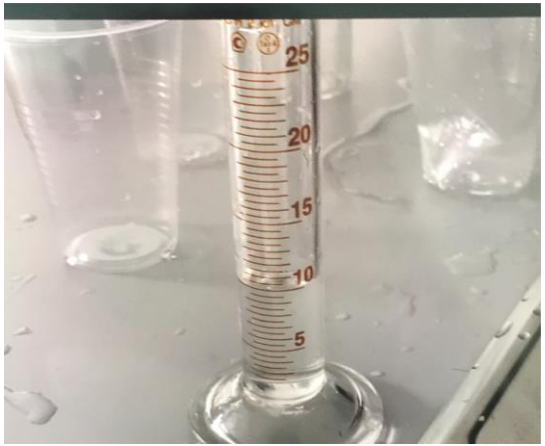
Water

We used at first 20 ml

Then 15 ml

And then 10 ml





The least amount of water we used and was successful

The last successful amount of water was exactly 10ml

Unsuccessful

We used less than 10 ml (~9 ml, 8 ml) but the experiment was not successful.

The area of the water could not fill the space on the paper needed and that resulted in different pressure and mass identification

CONCLUSIONS

- The least water we can use so that the atmospheric pressure can help the phenomenon are only when the entire area of paper inside the cup is filled.
- The hypothesis was confirmed with the results of the experiment when using a total surface of the the cap was 38,425 and the water was a little less than 10 ml.
- There were no other beakers to test more about the shape of the glass, the size of it and the type of paper.

REFERENCES

- https://physics.stackexchange.com/questions/73201/about-an-upside-down-cup-of-water-against-atmosphere-pressure
- http://sciphile.org/lessons/upside-down-water
- https://www.quora.com/When-we-flip-a-half-filled-water-cup-with-a-paper-placed-inits-mouth-upside-down-then-the-paper-doesnt-fall-For-this-to-happen-the-pressure-outside-the-cup-should-be-greater-than-the-pressure-inside-How-does-this
- https://www.questacon.edu.au/outreach/programs/science-circus/activities/upside-down-water

Thank you for your attention!