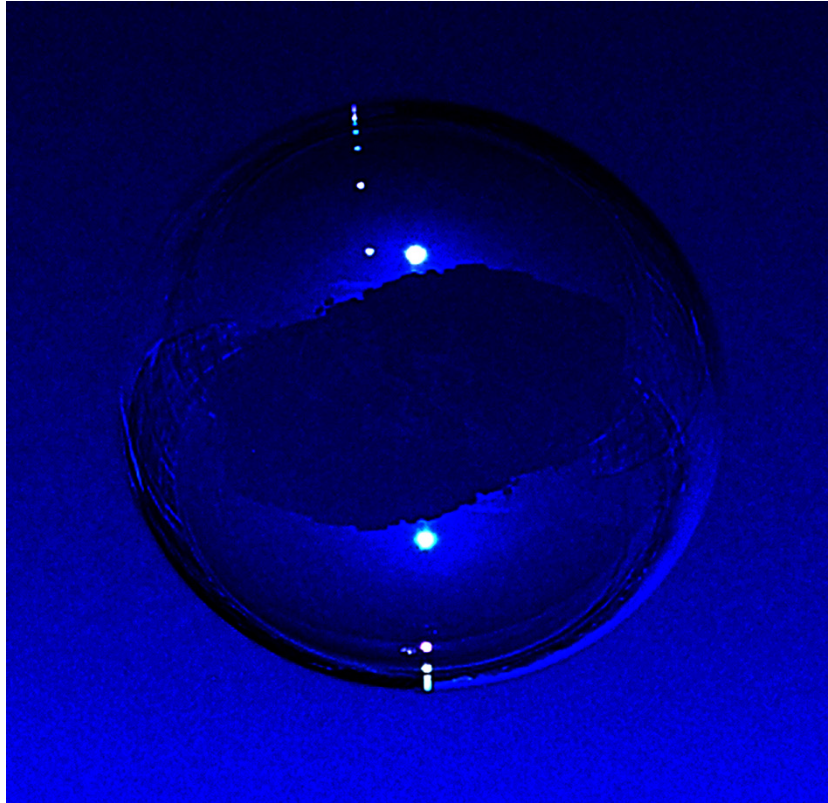


Reflection Sphere



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Abstract

The Reflection sphere image was taken for the first group assignment of the University of Colorado at Boulder Mechanical Engineering course MCEN 5228 – Flow Visualization. The objective of this assignment was to create fluid phenomena and capture the phenomena in an image. The Reflection Sphere image was intended to demonstrate the surface tension effect seen in bubbles as well as display the reflective characteristics of curved surfaces. The image was taken in the hope that with this visualization more individuals will be able to appreciate and understand the complex fluid relations behind this commonly seen phenomenon.

Image Set Up

The image was taken outside and illuminated by natural light coming from the sun that was positioned 45 degrees above the horizon from directly behind the camera. The background of the pictures was set up so that behind the bubble was clear blue sky and surrounding the bubble were buildings and other recognizable features. Additionally, the image was taken at an upward angle towards the bubble, as seen in Figure 1, from approximately 7 feet away in an attempt to increase the effect of the reflected image.

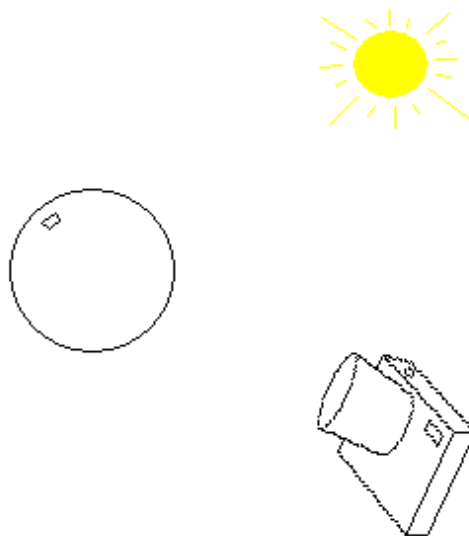


Figure: 1
Set up for Reflection Sphere image.

The bubble represented in the image was created by filling a bowl with about a half of an inch of water and a table spoon of Palmolive Ultra, aroma sensations, concentrated dish liquid. Then, with a three inch diameter ring, a film of the dish liquid was blown into a bubble about one foot in diameter. Once the bubble released from the ring, the ambient wind gently lifted the bubble to about 15 feet off of the ground, where the picture was taken.

Phenomenon Explanation

The phenomenon seen in the image is an example of the Surface tension effect which describes how liquids hold onto each other and create spheres due to that shape being the lowest energy state. The soap bubble exists because the surface layer of the water in the mixture has a higher than average surface tension. A bubble made with pure water alone is not stable; therefore a dissolved surfactant such as soap (or soap imitation in this case) is needed to stabilize the bubble. It is commonly misconceived that soap increases water's surface tension, where in reality it decreases it, lowering it to approximately one third of that of pure water. Therefore soap does not strengthen bubbles; it stabilizes them, by means of an action known as the Marangoni effect. Though the soap reduces the water's surface tension, the overall tension in a bubble is effectively doubled since the bubble's film has an inner and an outer surface. As the thin soap film on the outside of the bubble stretches, the surface concentration of soap decreases, this in turn causes the surface tension of the bubbles outer surface to increase. In laymen's terms, soap selectively strengthens the weakest parts of the bubble and tends to prevent them from stretching further. The spherical shape is also caused by surface tension effects. This surface tension causes the bubble to form a sphere, because a sphere has the smallest possible surface area per volume.

Camera Settings

The photo was taken as a digital image with a Casio EX-Z600 set with a focal length of 12.8mm in order to capture the entire bubble and none of the surrounding buildings. F-Stop of 6.5, exposure time of 1/800 sec, ISO of 400, size of 1282x1242 pixels, and an aperture value of 2.8 was chosen to capture the clearest image of the bubble. Cropping of the image to center

the bubble in the frame of view as well as an increase in contrast and sharpness was used to heighten the observed phenomenon. Colors were then adjusted to create a deep blue for the image.

Conclusions

This image shows the beauty that fluid flows can have and the complex physical phenomena needed to produce these events. Overall the image that was captured came out very well. The photo clearly presented the phenomenon that it attempted to convey and it was done in a visually pleasing way. The lensing effect and contrast in the bubble came out better than expected but unfortunately it came at the price of having to use a reduced capabilities camera. In the future, capturing this image would be easier if it could be done on a less windy day or inside a large open room.

Works Cited

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Original photo, pre-Photoshop edit.