Get Wet Spring 2018

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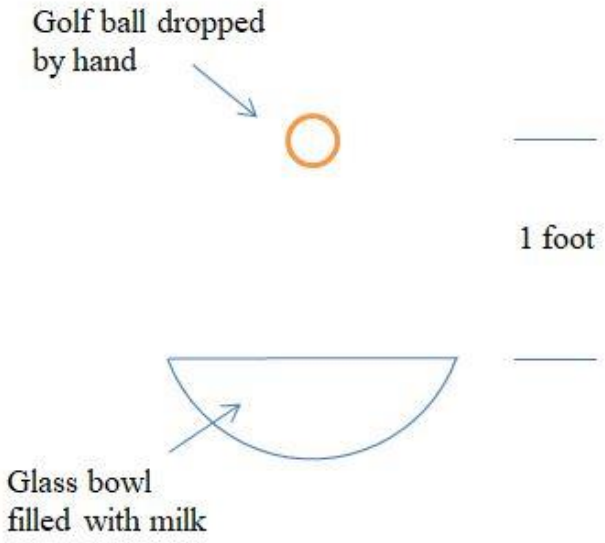
In creating my image I wanted to explore the flow phenomenon of dropping objects into a bowl of fluid. Originally, I started by dropping objects that were in my immediate surroundings with the only desired characteristics being small size and as heavy as possible. This immediately led me to dropping one, two, or more coins at once into the bowl of fluid. The resulting flow was interesting; however, I wanted to try a spherical object next in hopes of photographing circular wave patterns in the fluid. A golf ball met all of my criteria. It was spherical and heavy for its size.

The basic flow apparatus is shown below:



The camera was mounted on a tripod and was looking down at the bowl at an approximately 45 degree angle. Since the impact was not recorded on high speed camera it is difficult to obtain numbers such as speed or time of the flow. The following calculations are simply based on the

[1] Plateau–Rayleigh instability. (2018, February 10). Retrieved February 18, 2018, from https://en.wikipedia.org/wiki/Plateau%E2%80%93Rayleigh_instability

fact that the image is sharp and there is no motion blur with a shutter speed of 1/40 s. In order for no motion blur to occur at that shutter speed, the fluid would need to be moving at a speed of 0.0000025 m/s. This was calculated with the assumption that motion blur would be visible if the fluid moved more than 0.1 mm during the time that the shutter was open. Since the shutter was only open for .025 seconds, the fluid would have to be moving at 0.0000025 m/s to not cause motion blur. Other data can be approximated from the photo such as length of the flow. In the photo the bottom of the golf ball is approximately at the surface of the fluid pool, and the top of the flow is near the top of the golf ball. Since the diameter of a golf ball is approximately 1.68", I am concluding that the length of the flow is also 1.68" or 0.0426 meters. The last piece of information required to find the Reynolds number of the flow is the kinematic viscosity of the fluid. The fluid I used is coconut milk and for ease of calculation, I am assuming the kinematic viscosity of coconut milk is the same as water, $1.004\ x\ 10^{-6}\ \frac{m^2}{s}$. Therefore the Reynolds number of the flow at the moment at which the photo was taken is:

$$Re = \frac{UD}{v} = \frac{.0000025\ \frac{m}{s} * 0.0426\ m}{1.004\ x\ 10^{-6}\ \frac{m^2}{s}} = .106$$

A Reynolds number of .106 is extremely low and suggests that the photo was taken near the moment at which the flow was stationary. Besides the Reynolds number, I was curious about other parts of the flow phenomenon. Specifically, I was interested in why the fluid splash around the golf ball turned into droplets at the end. Upon further research, I learned the decay from cylindrical jets to droplets is accounted for by the Rayleigh-Plateau instability. The driving force behind the Rayleigh-Plateau instability is that liquids tend to minimize their surface area. This is due to the surface tension of the fluid [1].

The materials used in the setup described earlier were coconut milk as the fluid in the glass bowl, a golf ball, and a black piece of felt underneath the bowl. The photo was taken indoors with the room lights off and the blinds closed to block off all external light sources. The light for the photo was provided with an external flash connected to the top of the camera.

The idea behind the photo was to capture the exact moment that the ball hit the surface of the fluid and not to capture anything else because it would be distracting. Because of this, I wanted little motion blur and a shallow depth of field. The camera used is a digital Nikon D80 on a tripod approximately 1.75' from the subject. The original image was shot in a NEF format and was 3872 x 2592 pixels, the final image was converted to PNG at the same size. The exposure was 1/40s at f/5 with an ISO of 400. The focal length was 105 mm. This lead to a field of view of 4.73" x 3.12". The image was manipulated in Adobe Photoshop using Camera Raw. The contrast was increased to make the distinction between the golf ball and the milk more obvious by increasing the shadows. The original image is shown below:

[1] Plateau–Rayleigh instability. (2018, February 10). Retrieved February 18, 2018, from https://en.wikipedia.org/wiki/Plateau%E2%80%93Rayleigh_instability

I believe the image is fun to look at and genuinely just a stroke of luck. However, I think the image brings up more questions about fluid physics than it answers. I would show this image to someone and I would expect them to say “Wow” not “The flow phenomenon is very obvious”. Although I believe this is what I was trying to capture. I did not set out with a particular flow in mind that I wanted to photograph. I simply wanted to create an image that was fun to look at. If I were to do it again, I would make sure that the golf ball was spotless and there is no text showing on it.

[1] Plateau–Rayleigh instability. (2018, February 10). Retrieved February 18, 2018, from https://en.wikipedia.org/wiki/Plateau%E2%80%93Rayleigh_instability