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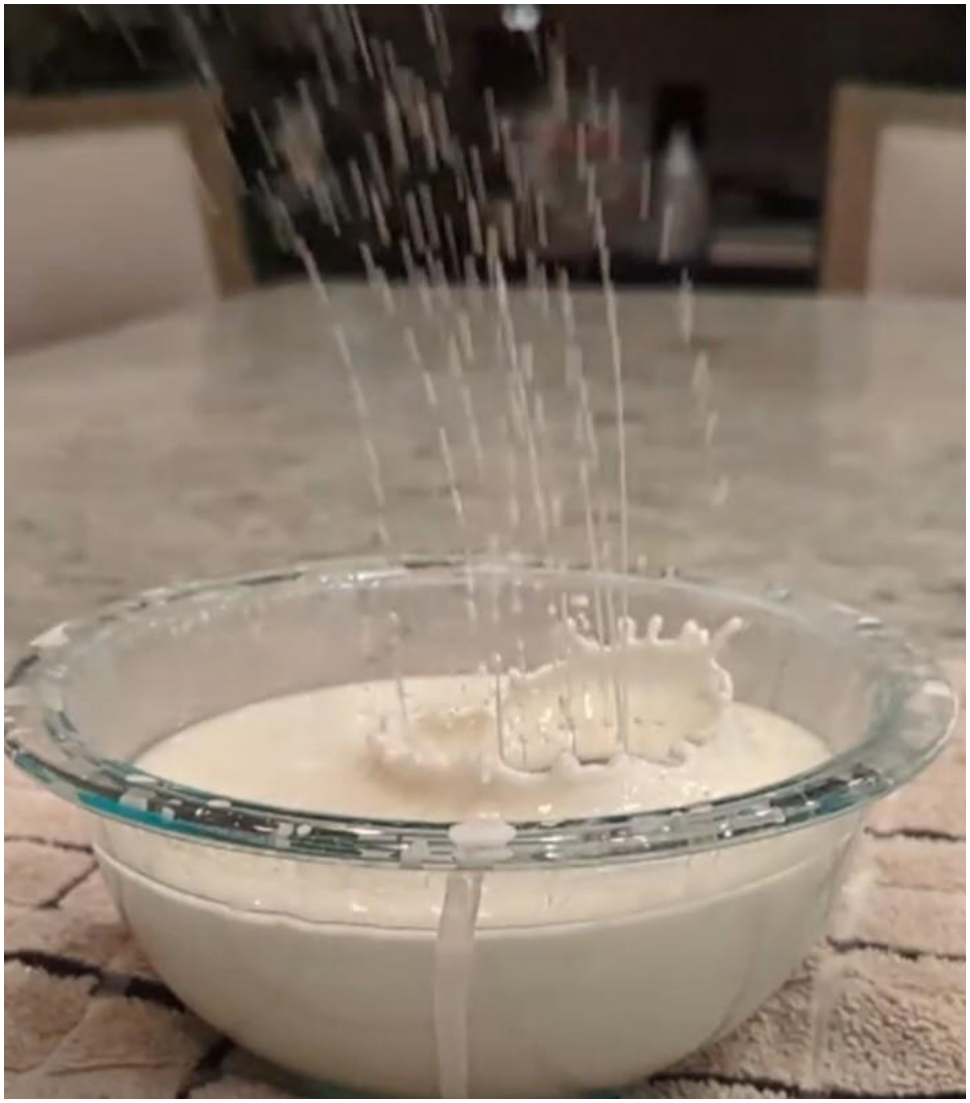
Team Third
Flow Visualization 2023
12/6/2023



The video was taken for the Team Third assignment for Flow Visualization. The goal of this assignment was to use your team as a resource when capturing some type of flow phenomenon. The purpose of this video was to show the flow of a more dense liquid by adding cornstarch to water.

In order to achieve the physics that are seen in the video, 2.5 cups of water was mixed with about 1 cup of cornstarch in a glass bowl. This is what caused the white color of the liquid. First, the top of a pepper shaker was dropped into the bowl from 3 feet above the surface of the liquid. After that, the top of a frosting dispenser was dropped from the same height as the

pepper shaker. These objects were chosen as their geometries made it so that the flow of the liquid through the object was easy to visualize.

The primary force that caused the visuals was gravity. By lifting each of the objects above of the surface, potential energy was built up. Then when the objects were released, that potential energy turned into kinetic energy from the force of gravity. This caused the large crown splash that can be seen around both objects. The force that was brought upon the liquid broke the surface tension and caused some of the liquid to split into droplets after exiting the holes of each object. This can very clearly be seen in the second clip of the frosting dispenser lid being dropped into the mixture. At first, it is a single stream that ejects through the hole, but then this stream breaks into droplets.

A piece of information that will provide more insight into the flow is the Reynold's Number. This will provide whether the flow had laminar or turbulent behavior. The equation for the Reynold's number is:

$$Re = \frac{\rho u L}{\mu}$$

With ρ = the density of water, $u$ = the flow velocity, $L$ = the channel diameter, and μ = the dynamic viscosity. Since the mixture used in this experiment showed behavior closer to water than a more viscous liquid, density and viscosity will be estimated as water properties. Substituting the values of the flow in this experiment for the frosting dispenser lid:

$$Re = \frac{998 \frac{kg}{m^3} * 1 \frac{m}{s} * .007\ m}{9.75*10^{-4}\ Pa*s} = 7,165$$

Since this value is much greater than 3500, it is safe to say that the liquid that shot out of the frosting dispenser was turbulent (Engineering Library). This result comes as no surprise as the movement of the liquid seems quite sporadic as throughout the experiment.

Nothing was added to the liquid other than cornstarch. The cornstarch gave the liquid its white coloring of the prior dilution of 2.5 cups of water to 1 cup of cornstarch. The cornstarch, frosting dispenser, and pepper shaker lid can all be purchased from most grocery stores. The only source of light was ceiling lights in the kitchen where the experiment was conducted.

A Google Pixel 7 Pro was used to capture the video. This phone records at 60 fps. When recording the video, the camera was about 2.5 feet away from the bowl. This distance was chosen to keep the quality as high as possible without having the liquid splash on the phone.

The original videos were shot in 1920 x 1080 and the final video was cropped and edited to 1080 x 1920. The main edit was slowing the video down to 1/8s to more clearly see the fluid physics. In addition, the videos were cropped, a title card was added, and music was put in the background.

I am mostly satisfied with how the video came out. I think a lot of interesting physics can be seen. However, I would change the color of the mixture or the background if this were repeated to make the liquid more clear. Additionally, not enough cornstarch was added to make the water as thick as I would have liked.

Citations:

Engineering Library
https://engineeringlibrary.org/reference/laminar-and-turbulent-fluid-flow-doe-handbook

American Physical Society
https://physics.aps.org/articles/v7/73