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Group Project #2
Flow Visualization
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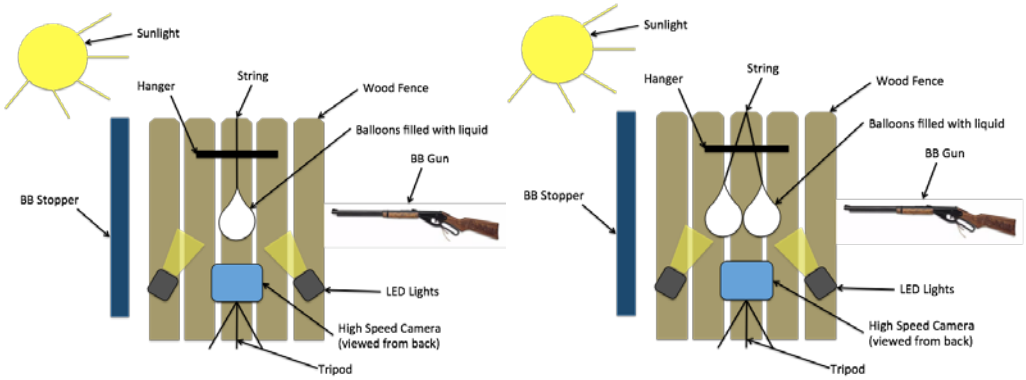
Video link
https://vimeo.com/144414344

Purpose:

The purpose of this image is to capture the physics and reaction involved in a popping balloon. Many people have seen balloons or other containers of liquid break but with the use of a high speed camera the physics can be described when capturing such an image. The seemingly act of chaos within the liquid following the break can be caught in an artistic way. The use of video can allow for a viewer to appreciate the entire reaction from start to finish. The video was taken in collaboration of my team including: Chris Obrien, William Olson and Gamal Elbialy.

Flow Setup:

The decision of capturing breaking of balloons required an integrate setup. The basics included suspending the desired latex balloons by a string or wire and then puncturing the balloons with a high speed small ball bearing from a bb gun. **I**n order to produce our desired subject we needed a set up that would allow us to capture the action with a high-speed camera. Due to the use of the camera, the Olympus I-Speed, it was necessary to perform our experiment in a very well lit area. In order to acquire enough light we conducted the experiment in direct sunlight with the addition of two hand held portable led lights. We placed the Olympus I-Speed approximately 5 ft from the subject with the background being a wooden fence that as stated before was in direct sunlight. The balloons were held at approximately 1 ft. from the fence by a hanger and left until they were completely motionless. With the balloon(s) in place we proceeded to carry out the plan and shoot them with a bb gun. The shot was taken at perpendicular angle from 10 to 15 ft. away. According to the specs the BB left the Daisy Red Ryder BB gun and was travelling at a rate of 350 feet per second as it entered the balloon. We began recording 20 seconds before the shot was taken and ended when all the liquid left the image frame.



Visualization technique:

Although the lighting was important, it was also important to find a way to further add color to the liquid. The use of food coloring inside the balloons made it easier to capture the flow following the rupture of the pressurized balloon. With food coloring, there was minimal transparency in the liquid allowing us to capture all the reactions of the liquids following the shot from the metal BB and all the physics were observed. When the BB initially punctures the balloon, the latex fibers of the balloon that were originally in tension contract in all directions away from the hole. At first, the water maintains the shape of the balloon after the pop, but as gravity pulls the water downwards the air resistance separates the water due to friction [1]; additionally, as the latex contracts and pulls away from the water, it creates a void, which causes the water to splash out to try and fill their air space created.

When the balloon originally pops the retracting latex applies a force called skin friction to the liquid. Skin friction is a type of parasitic drag caused by viscous drag within the boundary layer. The boundary layer from skin friction usually starts out as laminar, but turns turbulent eventually. [2] Although it is very difficult to see enough detail in the video taken of the balloons popping, if the boundary layers were examined it would be expected to see an originally laminar flow that turns turbulent.

Photographic technique:

As stated the Olympus I-speed camera was used to capture the video. Due to the limited amount of natural lighting from taking from the afternoon the video was taken at 600 fps and played back at 30 fps. IMovie was used for post processing, a minimal amount of work was done to the video other then a slight adjustment in brightness to

lighten the photo without distorting any of the image. Along with brightness adjustments the video was played in reverse then in forward for an artistic affect. Some of the other specs were lost when the camera was returned and the original video files were converted to a different format.

Safety:

When working with a BB gun such as the Daisy Red Ryder it is important to take safety precautions to ensure nobody gets hit with a BB. To do this, before cocking the gun, we first always made sure everyone maintained a safe distance from the balloon. We also created a setup that allowed the balloon to be suspended without the use of a team member holding it. The balloon was held by a string that was attached to the top of a fence with a clothes hanger placed between the fence and string to separate the balloon from the wall. To eliminate any chance of ricochet from the BB a thick comforter was placed as a backdrop for the BB.

Summary:

Overall the video does a great job of showing the physics involved in a breaking balloon as well as capture it in an artistic manor. While the video plays it in reverse it allows for a few moments of interest before it becomes clear on what is taking place. The dark color of the purple balloon also almost looks as if it is a shadow to the blue balloon before the video goes to play in real speed. Although with more lighting and a higher setting for frames per second may have allowed for the video to be played a little slower the video explains the physics well.

Sources:

[1] http://science360.gov/obj/video/ef933250-6e76-4b2e-b653-99ce6394ca63/physics-popping-water-balloon

[2] https://en.wikipedia.org/wiki/Parasitic_drag#Skin_friction