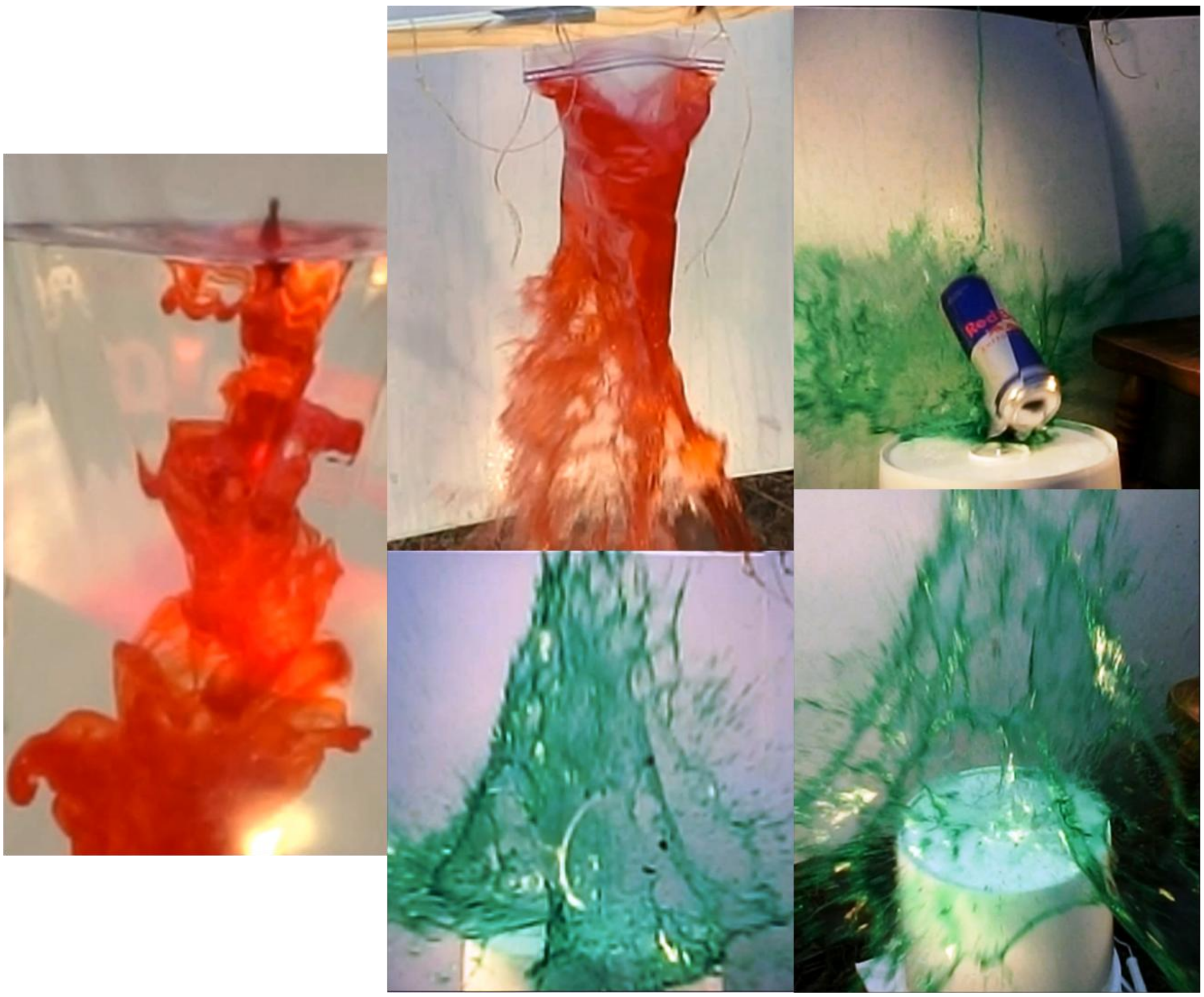
Firecracker vs. Water
Get Wet Assignment



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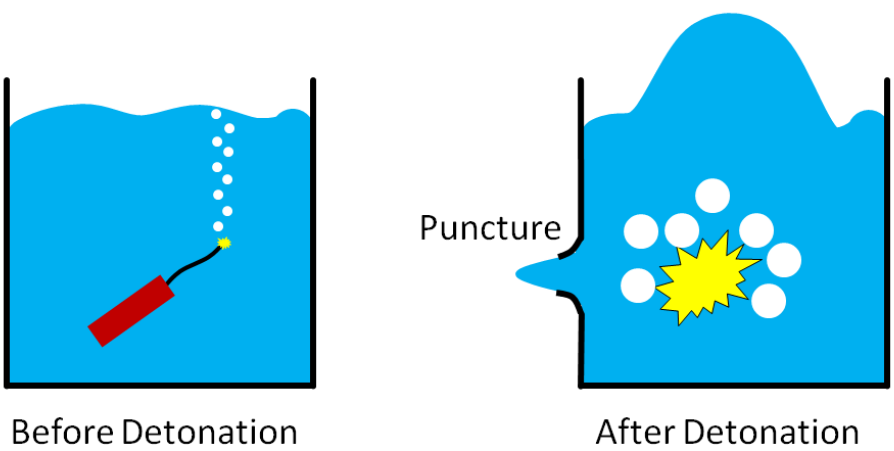
Purpose

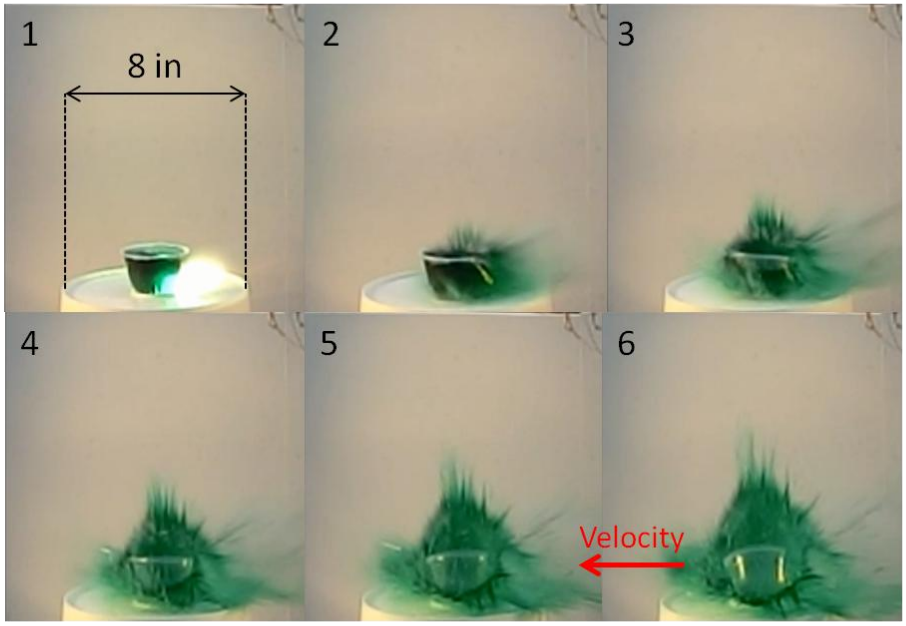
For my video I was looking to visualize the low compressibility of water and how it effectively transfers energy. To do this I took high speed video of small firecrackers exploding in three different containers (sandwich bag, aluminum can, and jello cup) of dyed water. This was a good way to depict the relative incompressibility of water because the rapid expansion provided by the firecracker was effectively delivered to the container containing it, something that theoretically wouldn't happen if the liquid used was compressible.

Flow Apparatus

Though three different containers were used to depict waters incompressible nature, the core concept of a submerged firecracker being detonated in an open container of water was continuous throughout each scenario. The waters flow is relatively static until the firecracker explodes at which the rapid expansion created quickly imparts its energy in to the water. "The low compressibility of non-gases, and of water in particular, leads to their often being assumed as incompressible. The low compressibility of water means that even in the deep oceans at 4 km depth, where pressures are 40 MPa, there is only a 1.8% decrease in volume."[1] This low compressibility doesn't allow for the water to absorb much of the energy from the blast, so as the energy travels through to the edge of its volume the water looks to expand in the direction of least resistance. I all of my experiments the direction of least resistance for the water was through the container itself, puncturing or destroying the container all together.



Continuing to dissipate its energy the water exits the container with varying velocities. To calculate a random sample velocity I measured the time it took the left wave of water to reach the side of the bucket (around 4 inches away) from the jello cup clip. To find this time, I observed the amount of frames that passed in my 480 fps shot to be 6 frames. Knowing that I divided the 6 frames by the 480 fps frame rate to find the time, which was 0.0125 seconds. Plugging that and the known distance in to the velocity formula I found the water's velocity to be 320 in/s or 18.2 mph.



(6 frames at 480 fps)

Visualization Technique

To enhance the visibility of the clear water I added different colors of food coloring to it. Also to provide contrast to the dyed water I hung white poster boards in the background. These poster boards also turned out to be a good surface to see the liquid impact and splatter upon. As for lighting, the rule of thumb for shooting high speed videos is usually the more light the better. With that in mind the clips were shot in daylight with two auxiliary high intensity construction lamps focused on the water containers as shown below. The locations of the lamps were altered from shot to shot as well.

Photographic Technique

As previously stated, I choose to record this phenomenon through high speed video. Two Casio EX-ZR100's capable of recording up to 1000 fps (frames per second) were used simultaneously to record different angles of each explosion at different frame rates (240fps at 432x320 and 480fps at 224x160). Frame rate was limited during the shoot because increased frame rate was recorded at a lower resolution and quality corrupting the shot. The Casio also benefited from a 12.5 optical zoom allowing the operators to take a safe distance from the explosion while still keeping the subject in frame. Being able to shoot the same explosions from two different angles, more detail was achieved giving the viewer better perspective of the explosion. Helping to shoot these clips and set up the experiments were Blake Buchannan and Austin Nossokoff. Post processing was done in Windows Live Movie Maker where the clips were trimmed to size, stitched together, and brightened.

Reflection

I thoroughly enjoyed how my video turned out. I feel that the high speed video really was effective in slowing the action down and show the physics of the flow of the water after the explosion. For improvement to my video, I would use a higher quality high speed camera that could capture more detail at higher frame rates and would also add music to my video. To develop this idea further I would try and alter the location of the explosion instead of having all of the blasts come from the bottom of the container and maybe even use different liquids to see how they react to explosions.

[1] "Properties of Water." *Wikipedia*. Wikimedia Foundation, 02 Oct. 2013. Web. 12 Feb. 2013.