Get Wet Report - Fall 2025

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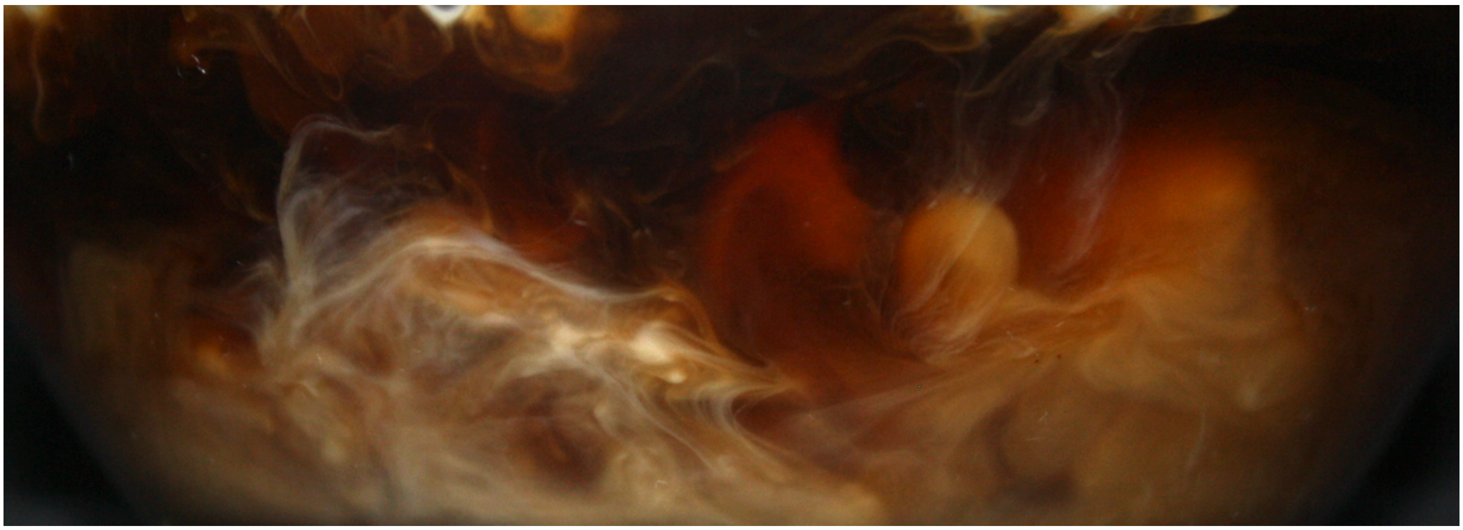
MCEN 5151-001

September 23, 2025

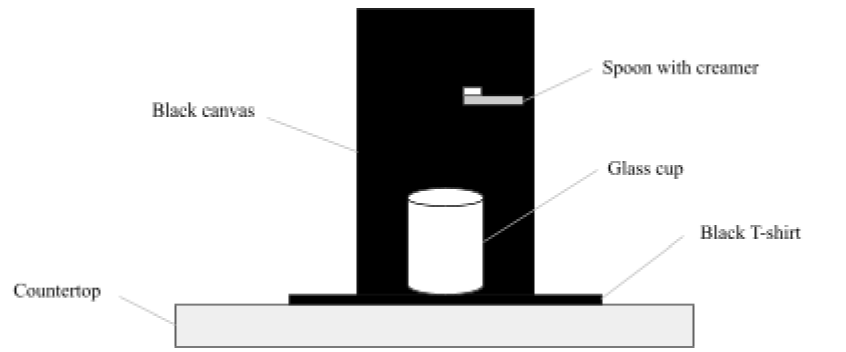


Purpose and Context

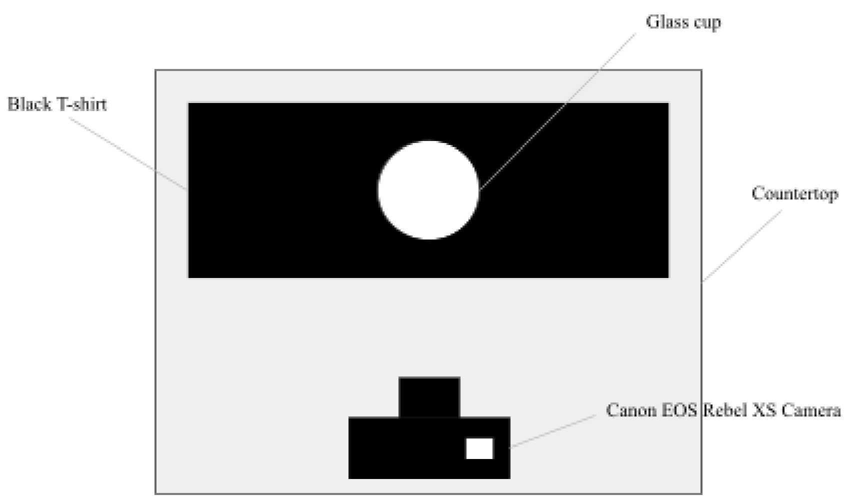
The intent behind this image was to capture the turbulent effect that occurs when two liquids of different densities collide. This experiment was performed as a part of the Get Wet assignment, designed specifically as an introduction to capturing the artistic flow of a given fluid. Given that I had little camera experience before attempting to take this image, the personal goal that I had in mind was to become familiar with different camera settings. I found that I had all of the necessary materials for this setup in particular, and I had a basic understanding of the physics behind coffee and creamer mixing. Not only did the convenience of this experiment entice me, but I also wanted to display the beauty behind everyday phenomena that we take for granted.

Materials and Methods

This experiment was set up with very few materials, mainly household items to which I had easy access. The vessel that I ended up using was a short, stemless wine glass to make the visuals of the coffee and creamer easier to see. I also propped a dark black canvas behind the glass to enhance the white nature of the creamer. After some trial and error, I found that the granite countertop was affecting my image with the reflection it produced. To try and limit this reflection as much as possible, I decided to lay a black T-shirt under the glass and canvas. I used a room temperature bottle of Starbucks cold brew, along with a Kroger Caramel-Vanilla creamer. Figure 1 below displays this setup from both the camera POV and the POV from above.



From camera POV



From above POV

Figure 1: Final setup of coffee and creamer experiment from two POVs

With all of my materials prepped and ready, I started to pour the creamer into the glass with the coffee. I found that it was quite difficult to capture the turbulent mixing when directly pouring creamer from the container, so I adjusted the pouring technique by taking a small amount of creamer on a spoon and slowly allowing it to fall into the coffee from about 3 inches above the glass.

Fluid Dynamics

The key physical phenomenon that this photo displays starts with the conflicting densities as the creamer hits the coffee. As the dense creamer hits the slightly less dense coffee, this effectively causes Rayleigh-Taylor instabilities to rise due to the light fluid (coffee) having to push the dense fluid (creamer) when they interact within the glass vessel near the center of the flow [3]. In order to predict what kind of motion is present once these two fluids interact, we have to take a look at the Reynolds Number that is produced by solving the following equation:

$$Re = \frac{\rho v L}{\mu} = \frac{(1050\ \frac{kg}{m^3})*(0.1\ \frac{m}{s})*(0.07602\ m)}{0.0071\ (\frac{kg*m}{s})} = \frac{7.9821}{0.0071} = 1124.24$$

Generally, it has been proven that a Reynolds Number less than 2000 is laminar flow while anything above 2000 is turbulent [2]. Seeing the number that was calculated, we find that this particular case of mixing was predominantly led by laminar flow, though a lot of the mixing might deter one from coming to that conclusion based on visuals alone. This should be taken with a grain of salt, however, since general turbulent and laminar flow are predicted assuming the vessel is a pipe (which is not true in this case).

There is also the presence of an increase of entropy in this system due to the different liquids combining. At the beginning stage when both fluids are separate, they are in a relatively low state of entropy since each fluid is uniformly distributed on an individual level. However, as the creamer begins to mix with the coffee, the initial structure and order that was present for each individually is lost, allowing for more disorder to arise, inherently increasing the overall entropy that is observed within the glass [1].

Visualization Techniques

As I stated in the purpose of this experiment, I have very little experience when it comes to capturing images with a camera, much less capturing a moving fluid. The lighting that I had access to was not ideal, so I opted to use the camera flash when I was capturing this image. I also didn’t have too much knowledge on operating a camera in manual mode, so I set my camera to its automatic mode (including automatically focusing), so a large portion of this image was determined by the camera. The following table shows the exact camera settings (taken from the metadata of the photo):

Camera Settings	**Value of Settings (from metadata)**
Focal length	43mm
Aperture	f/5
Exposure time	1/60 s
ISO	100
Size	3888 x 2592

The original image itself included too much of the vessel and background showing, so in post-processing I made sure to crop most of that out to ensure that the focus was on the mixing fluids. I also decided to play around with the RGB curve within the image, settling on the typical "S-curve" that increased the brightness of the light colors and deepened the darkest shades seen in the image. The figure below displays the extent to which I edited the photos, the original on the left and the final image on the right.

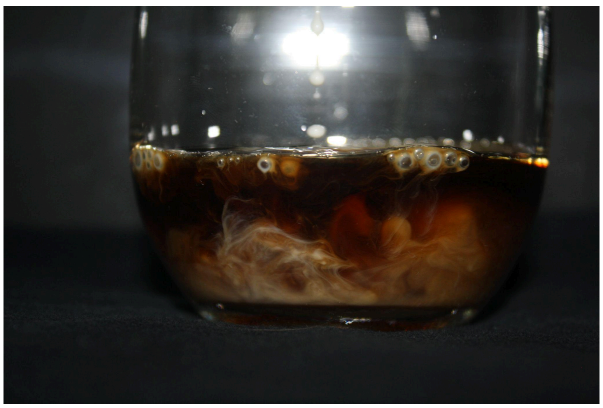
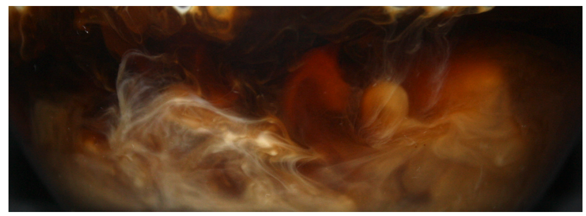
Initial Image	Final (Edited) Image
	

Figure 2: Initial and Final Images

Conclusion

Not only did this image display the beauty within the ordinary, but it also highlighted the physics that can be analyzed within everyday phenomena. The brilliance of Rayleigh-Taylor instability arriving from different densities, laminar flow, and an increase in entropy are clearly visualized, providing a beautiful insight into the physics of everyday life. I thoroughly enjoyed the depth that this image provides, showing that this mixing is occurring within the entirety of glass rather than just at the surface and near the edges. If I were to perform this experiment again, I would like to dive deeper into manually adjusting my camera settings to capture a clearer image. I would also like to improve the framing of the image, maybe including the laminar flow arising from the creamer pouring out of the spoon and into the glass.

References

[1] Aaronson, Scott, et al. "Quantifying the Rise and Fall of Complexity in Closed Systems: The Coffee Automaton." *arXiv.Org*, 27 May 2014, doi.org/10.48550/arXiv.1405.6903.

[2] Saldana, Manuel, et al. “The reynolds number: A journey from its origin to modern applications.” *Fluids*, vol. 9, no. 12, 16 Dec. 2024, p. 299, https://doi.org/10.3390/fluids9120299.

[3] Sharp, D.H. “An overview of Rayleigh-Taylor instability.” *Physica D: Nonlinear Phenomena*, vol. 12, no. 1–3, July 1984, pp. 3–18, https://doi.org/10.1016/0167-2789(84)90510-4.