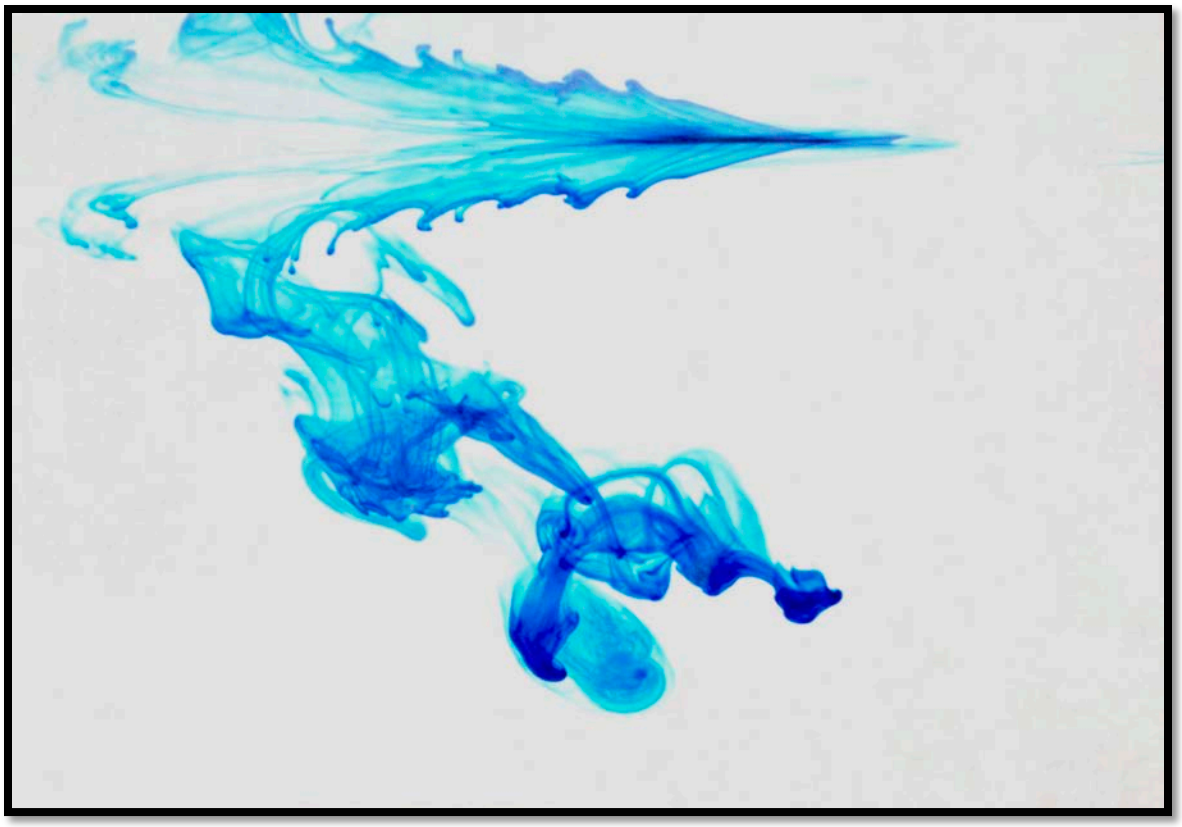
# GET WET- Project 1



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**Flow Visualization**

**Purpose**

The purpose of this image is to depict the random motion of a fluid as it interacts with another fluid in a vibrant and artistic way that shows the beauty in fluid dynamics. In the course of Flow Visualization this is the first assignment and the goal of this assignment is to be familiarized with fluid phenomena and understand some of the difficulties that may be encountered when trying to capture and depict such a situation. Working with Billy Olson and Chris Obrien we were able to capture the final image.

**Fluid Phenomena**

Although a few different situations were experimented, it was chosen to depict the mixing of food coloring into water. Due to the fact that the food coloring and water have different properties an outcome can be visualized. Before the two liquids have a chance to diffuse and fully mix together there is a boundary layer that can be seen between the two of them. The instability is caused by the fluid with less density to rise while at the same time the fluid with a higher density wants to lower. (2) This is what creates the odd and beautiful shapes between the fluids. The density of the food coloring is slightly greater then that of water thus causing it to sink, after it enters the water at a slow and laminar rate. While the heavier dye sinks through the water it does so in a peculiar manner, which can be known as the Rayleigh-Taylor instability. Below is the calculation for the Reynolds number of this flow using the following constants:

Velocity of fluid, u=2.5ft/20sec

Density of water, $\boldsymbol{\rho}$=62lb/ft^3

Length/distance, L=2.5 ft

Viscosity of water, $\mu = 2.034\ \text{lb/s} * \text{ft}$

$$\boldsymbol{Re} = \frac{\boldsymbol{\rho} * \boldsymbol{u} * \boldsymbol{L}}{\mu} = \mathbf{95.2}$$

Due to the fact that this Reynolds number is so low it is obvious that the flow is indeed laminar and allows for the Rayleigh-Taylor instability to take place and show for an interesting flow.(1) Along with this flow many times the result of a Rayleigh-

Taylor flow will cause vortex rings as the fluid sinks. Although not depicted in this photo it is often common (3). Along with the mixing of the densities there were a few other factors acting on the fluid. The water at which the food coloring was dropped into was not completely stagnant and since the top layer was moving to the left while the bottom section was moving the opposite direction to the right.

**Set up:**

In order to correctly capture the fluids interaction many setups were attempted with various lighting and positioning of the experiment. The final image utilized a ten-gallon fish tank (36" x 18" x 30"), a white paper background, standard blue food coloring, natural light and 2 lamps. The setup can be seen in the following images.

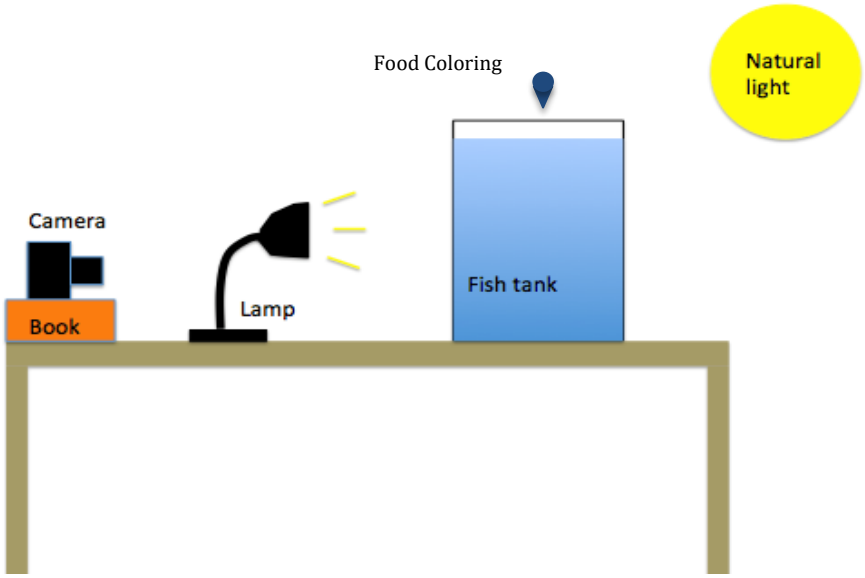


Figure 1: Setup side view

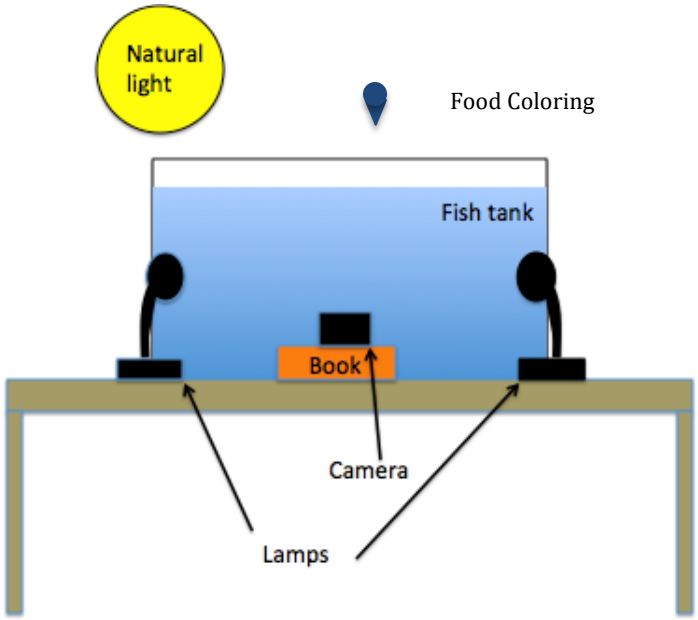


Figure 2: Setup Front view

The camera was placed approximately four feet from the fish tank when the photograph was taken. The fish tank was placed in door but directly in front of an open glass sliding door which allowed for the sunlight to light from behind and two lamps were placed at a diagonal angle in order to add even more light without causing any problems with reflections. A few drops of food coloring were added to the nearly full fish tank right after the fish tank was filled. The dye was only held about an inch from the surface of the water and the food coloring settled for approximately 20 seconds before the final image was taken.

**Camera**

The camera used was a Nikon D3100 with a fairly standard lens (18-55mm). With the camera slightly zoomed and from approximately 4 feet away I was able to capture most of the fish tank in the original image, an attempt was made to move the camera closer and try and focus more on the subject to allow for less cropping but focusing issues were encountered. The final image was cropped to focus on the area with the best focus and lighting to a size of 3929 x 2712 pixels. A focal length of 52.0 mm was used at an exposure time of 1/200 sec and the ISO for the camera was

set to 800. Along with cropping the exposure was also adjusted in post processing to lighten the picture and allow for a more true white background. Photoshop was the program chosen to carry this out. Somehow while post processing the original image was lost.

**Conclusion**

This image does a great job of showing the boundary between two different color fluids and how with the Rayleigh-Taylor instability the fluids act in a peculiar manor due to differences in the densities. Capturing the image was more difficult then expected but after manipulating camera setting, lighting and conducting multiple trials the image was a success. Addition tips and techniques learned in class will further my ability to capture a similar image that would require less post processing and be of better quality.

Sources


1. http://www.engineeringtoolbox.com/laminar-transitional-turbulent-flow-d_577.html

2. http://physicscentral.com/explore/action/mixing-physics.cfm

3. http://oatao.univ-toulouse.fr/604/1/joly_604.pdf