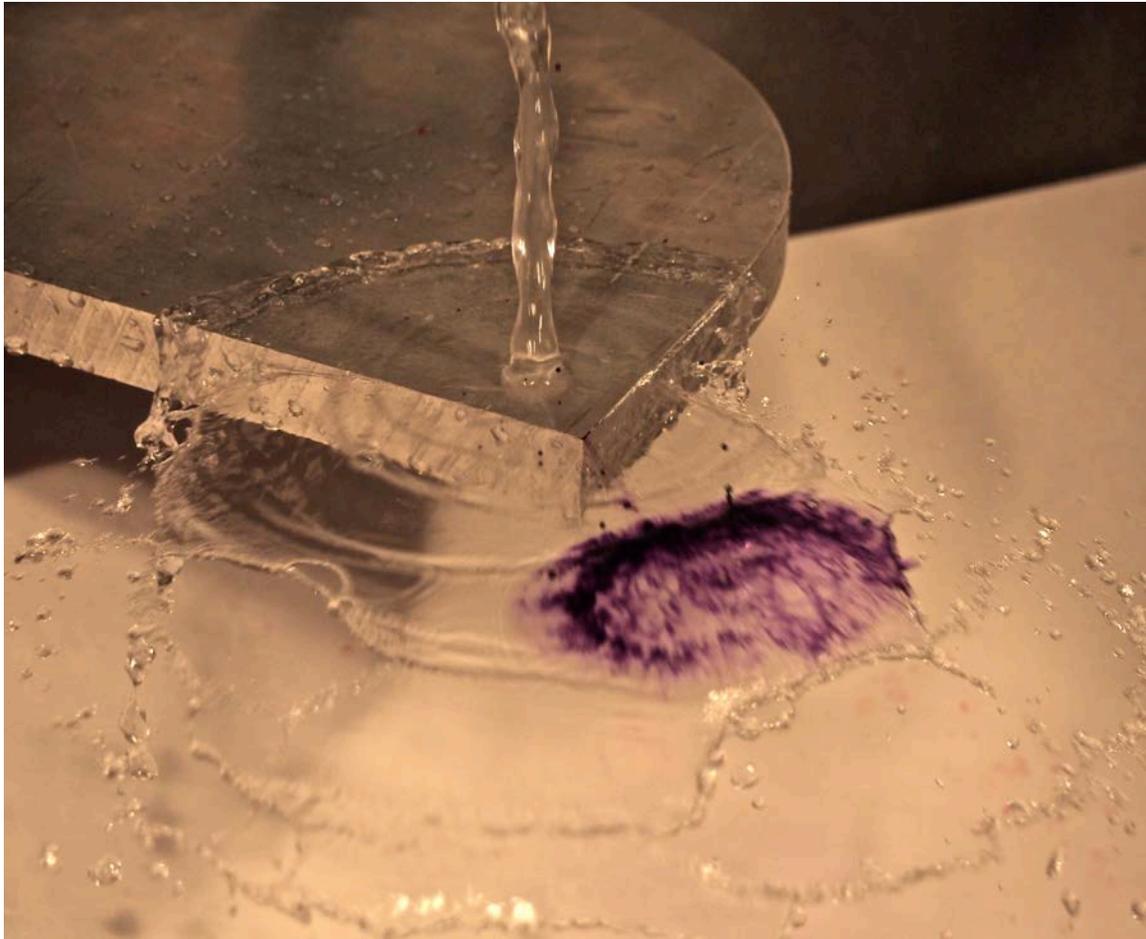


Team Project 1



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Special acknowledgment for experimental setup:
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Introduction

This was the first team project and as a team we decided to try and work with India ink and a simple experimental setup. As a group we wanted to see how India ink would disperse through flowing water. We also wanted to see how the water and ink would flow off the edge of a metal plate, and from it we all got pretty cool images.

Physics/Experimental setup

The flow apparatus in this experiment was a rather simple setup, and can easily be repeated. We were located in one of the machine shops down in the chemistry building, and the whole setup was contained within a large and deep sink. Initially we were holding the plate at an angle so the water would deflect into the sink, and for the particular image that I captured and submitted this was the setup used. As can be seen in Figure 1 someone was holding the plate while one person took photos and the other group members dropped the India ink into the flow of the faucet. The white backdrop was just a simple poster board. Several different edges of the metal plate were used to change the flow of the liquid. For my image I used the sharp corner on the metal plate.

Later in the experiment we set the metal plate on a metal basket in the sink and let the faucet flow over this, while dropping the India ink, which can be seen in Figure 2. Some of the other images submitted by my group used this experimental setup, and it can be seen that another metal plate was used as the background as opposed to the white poster board.



Figure 1: Setup used for my Image



Figure 2: Setup for other images

As far as the physics that are going on here, it is easy to see that a mixing process is occurring. Due to the miscibility of the two liquids they are able to mix rather quickly, and the fluid velocity of the water exiting the faucet speeds up this process. Mixing is able to happen due to the relatively low viscosity of the two

liquids. The viscosity of water around room temperature is usually around $1 \text{ mPa}\cdot\text{s}$. The viscosity of India ink is more difficult to classify, especially since the ink used (Bombay India ink) does not have these kinds of speculations. However from further research in the applications of this ink and similar water based inks the viscosity of India ink is somewhere between 1 and $10 \text{ mPa}\cdot\text{s}$ ¹. This value is also subject to change once in the flow of the water stream, making the viscosities very similar and the mixing process can be carried out more quickly.

Visualization Technique

The setup used in this experiment as mentioned before was simple and easily repeatable. We dropped India ink into a flowing stream of water coming from a faucet. The India ink used was Bombay India ink and was dropped in its original form. The lighting used in the experiment was two bright halogen work lamps that happened to be available to us down in the lab we were working in. Both lamps were setup surrounding the sink, one on the left side and one on the right in an orientation such that the shadows from the cages over the lamps didn't interfere with the main image at all.

Photographic Technique

The field of view in this particular image is approximately 10-12 inches wide by about 8 inches tall. The image was captured approximately 2 ft away from the lens of my camera. The focal length in this image was 40 mm, and the image is 4,214 pixels wide by 3,456 pixels high. I used a digital camera, the Olympus PEN E-PL5, with an Olympus 14-42 mm, 1:3.5-5.6 and 37 mm diameter lens. For this image the aperture was set to f/5.5, the ISO speed set to 200, and the shutter speed was $1/1250 \text{ s}$. In post-processing the images exposure was turned up almost all the way. The original image was rather dark due to the extremely fast shutter speed, so by adjusting the exposure in editing this can be solved. A simple cropping of the image was also performed to cut out the non-essential distracting portions of the image.

Image Results

Overall I am moderately pleased with the image produced here for the first team project. I really liked the idea and phenomenon we were trying to capture, and how it was different from normal experiments that involve India ink. At first when capturing the images, they all looked too dark, but after post-processing the exposure was able to be turned up and create a cool image. I like how I was able to capture this one droplet diluting at the moment the image was captured. The colored part of the image was perhaps a little blurred, so if this was going to be repeated I would use an even higher shutter speed and perhaps increase the ISO setting.

The physics I believe are shown well here, mostly due to the shutter speed at which the image was able to be captured. India ink in the form that we had procured it is meant to be diluted in water to create a larger quantity of pen ink or some other printer ink. The fact that the India ink is water soluble, and meant to be diluted in water is what made for such a cool image. If I were to take this experiment further I would see if I could change or improve several things. One

thing I would like to improve upon would perhaps be the light source. While bright and sufficient for the image captured in this project, I believe the greater the lighting setup, the faster shutter speed I can use and this would provide a little more clarity to the image. The setup and concept of this project was very cool, and if further work were to be done I would just like to mess around more and try a greater variety of images if possible.

References

1. "Indiamart-Products." *Indiamart*. N.p., n.d. Web. 13 Mar. 2014. <<http://www.indiamart.com/hi-shineinks-pvtltd/products.html>>.