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MCEN 4151 Get Wet Assignment
Feb. 14th 2012

The purpose of this assignment was to get acquainted with our cameras and capture a great picture of a fluids phenomenon. Initially I was setting up my camera to take photos of dye in water until I realized my backdrop was really cool looking. The picture I ended submitting in for this assignment was taken on accident – or at least I never had any intention to turn it in. I even had to email the professor to see if the photo was capturing what she considered a "fluid phenomenon". My picture was of a wine glass filled with water, the image in the water being clear and the background objects being out of focus. The image in the water shows the physics of refraction with the image being inverted (upside down) and backwards.

Figure 1: Post-Photoshop Photo

A convex lens will flip an image in two directions – both vertically and horizontally [1]. Here I believe the water in the glass acts as a convex lens. In Figure 2 you can see how parallel light rays from the top of the arrow travel through the lens and bend to go through the lens's focal point. Now if we draw a line from the top of the object through the lens's focal point before it goes through the lens it will produce a parallel line after it travels through the lens. Where the lines intersect on the right side of the lens is where the real image is formed. Notice how it is upside-down.

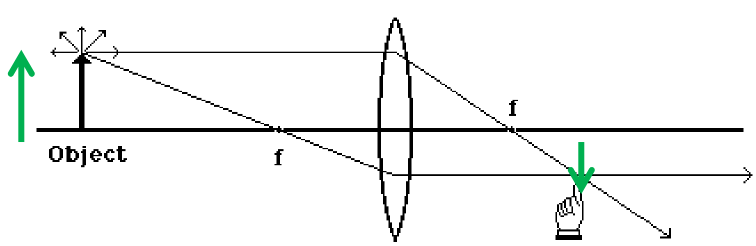

Figure 2: An object through a convex lens creates an inverted image [1]

I like how this next figure (Figure 3) shows more lines from the top, middle, and bottom of the arrow to show a better visual of how the image inverts. [1]

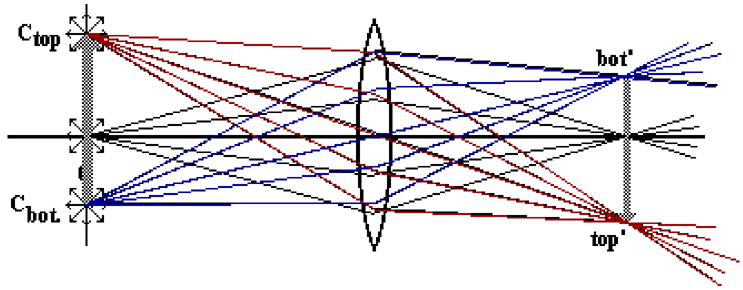

Figure 3: A more thorough concept of a convex lens [1]

So now that we know how a lens works we can discuss how water acts as a lens. This has to do with water's index of refraction. Snell's Law states that light rays bend when they pass through a different medium [2]. Water has an index of refraction of 1.33 [2].

$$N_o \sin\theta_o = N \sin\theta \qquad \text{Snell's Law}$$

Where N_o is the refractive index of the medium that the light ray is leaving, N is the refractive index of the medium that the ray is entering, θ_o is the angle of the light ray relative to the normal plane (relative to the interface of the two mediums), and lastly θ is the refracted angle relative to the normal plane previously defined. This is better understood in Figure 4. [2]

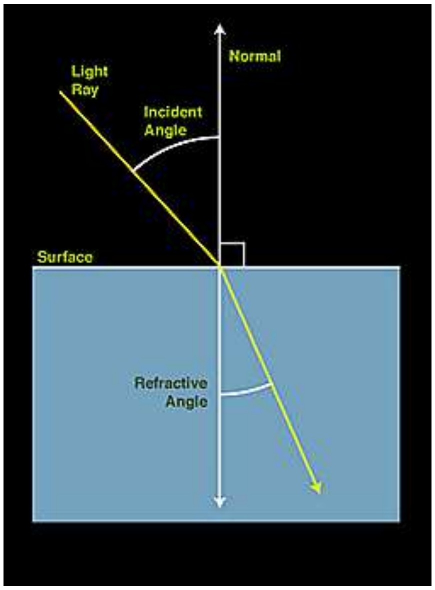

Figure 4: Snell's Law – Refraction [2]

As far as visualization techniques and recreating the image, there is nothing of high significance. You can make this inverted and backwards image with any double curved (more spherical) surfaced glass (like a wine glass) filled with any fluid. If you were to use a glass curved in one direction (looks most like a cylinder), such as a plain water glass, the image will only be backwards – NOT upside down. I used the natural light (sun) as my light source. My only recommendation in recreating this image is to make sure you have different colored bottles and different bottle heights; this will make the backwards image easier to identify.

The only Photoshop editing that I did to my picture was: remove blur at top of glass, increase the saturation, and crop the photo slightly.

Figure 5: Pre Photoshop Photo

I increased the saturation because I wanted to enhance the color in the photo; I thought it looked a little drab. I was also trying to give a more drastic color to the bottle on the right (the brownish-red bottle) to make it stand out more in the image in the wine glass. I also didn't crop much of the photo because I wanted the viewer to see most of the bottles in the back to really understand how the image has rotated and flipped in the water – a big contributor being the flat topped can on the right.

I used a Nikon D80 Digital camera with the following specifications:

Table 1: Camera Settings & Specifications

Size of Field of View	Top to bottom – 6 in
Distance from object to lens	12 in
Lens focal length	58 mm
Aperture	f/6.3
Shutter Speed	1/4000 sec
ISO	1600

Originally my camera was set to take pictures of dye in water and that is why my ISO and shutter speed are so fast – there is no need for them to be these values. I'm also farther away in this picture than some of the other wine glass pictures, and I liked how the whole picture looked when you could see more of the background, even if the background is super blurry. In Table 2 you can see I only cropped the picture a very little bit.

Table 2: Pixel Count

	Height	Width
Pre Photoshop	2592	3872
Post Photoshop	2523	3677

I think this image does a great job showing what a lens can do to an image. If I were to capture this moment again I would mess around with different ISO and aperture settings. I would also choose a different backdrop. I got lucky that I accidently took this picture and it came out interesting enough (and showed a physics phenomenon). Had this image been my intent I definitely would have made it more appealing and colorful. I also would like to have taken images of several different fluid mediums to understand different refractive indexes (had I known this was the physics I was going for). I will also use a tripod next time!

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[1] “Convex Lens: Real Images” Uploaded Jan 2001. Website. Accessed Feb.14, 2012. <http://homepage.mac.com/cbakken/obookshelf/cvreal.html>

[2] Reed, Rick. “Refraction of Light” Interactagram. Uploaded May 2009. Website. Accessed Feb. 14, 2012. <http://interactagram.com/physics/optics/refraction/>