This image was the third project and was taken individually. It is of a snowball that had burning Purell hand sanitizer on top of the snowball. The intent of the image was to show something on fire that you normally wouldn't see burning, and I came up with a snowball. The phenomenon that is observed in this particular image is simply the combustion of ethyl alcohol in an environment that allowed the alcohol to slowly burn off. There were no false starts with this image; it was chosen from a group of still images that all were taken in sequence because it represented the desired phenomenon the best. Also, to photograph the combustion of ethyl alcohol it is necessary to take the image in the dark due to the weak color of the flame.

There was no apparatus used for this image. It simply consisted of a 3.5-inch diameter snowball (placed on a concrete pad outside of my house) that had Purell on the top portion of the snowball and was lit on fire. Specifically, the setup required 4 pumps of the Purell liquid to be placed on the top of the snowball and then the Purell was set on fire by holding an open flame from an ordinary BIC lighter to it. Once combustion had started, the photographing of the flaming snowball began. The setup is shown in Figure 1. Purell was used in lieu of other hand sanitizers because it contains 65% ethyl alcohol.

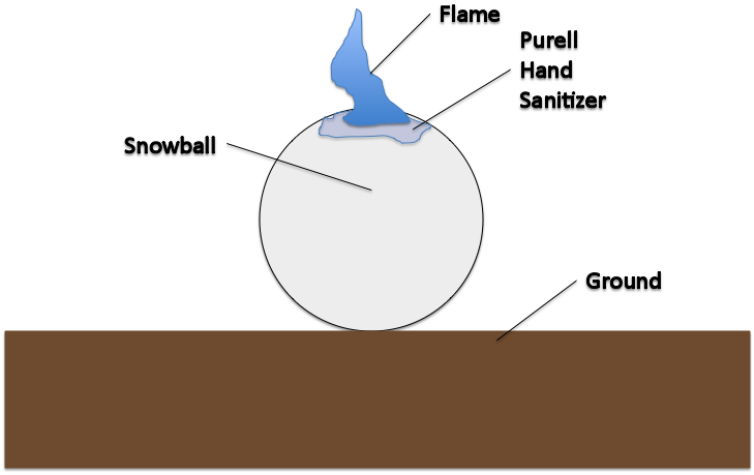

Figure 1: Photograph Setup

This is slightly higher than most hand sanitizers, which is why it was chosen. The other reason that Purell was used instead of another volatile liquid is that Purell has a relatively low vapor pressure of 40 mm Hg[1]. This means that it will not suddenly release a large amount of energy when ignited. Another important thing to note was that liquid hand sanitizer was chosen due to its viscosity. It was just viscous enough to stay "gelled" together on the snowball, but it also lacked a significant amount of

[1] http://www.monsterjanitorial.com/msds/cleaningmsdssheets/docs/27/2745/2745013.pdf.

viscosity, which allowed the Purell to flow down the sides of the snowball fairly slowly once it had been ignited. The Purell burned hot enough to cause the snowball to melt around the top portion where the Purell was placed and for the most part stationary (not flowing down the sides).

The chemical present in the Purell hand sanitizer responsible for the flame seen during combustion is ethyl alcohol (a liquid). It is makes up 65% of the liquid. The molecular formula for ethyl alcohol is C_2H_6O[2], also commonly represented as C_2H_5OH. The combustion of ethyl alcohol breaks down into carbon dioxide and water. The balanced combustion equation is governed by equation 1.

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_20 \qquad \textbf{(1)}$$[3]

The ethyl alcohol burned a bluish color throughout the combustion of the alcohol. The reason that ethyl alcohol burns blue is because of the lack of soot in the reaction as well as the burning off of the Carbon[4]. Also, ethyl alcohol burns at a relatively low temperature. For this picture I am estimating that the flame was around 900 degrees Celsius in the brighter regions, and the temperature is less than that in the regions that are less bright.

The visualization technique that was used for this photograph was simply an open flame. The flame emitted most of the light that is in the picture. As said above the combustible compound was Purell hand sanitizer (they ethyl alcohol is responsible for the burning). The air temperature when the image was taken outside was around 40 degrees Fahrenheit, with no wind, when it was relatively dark outside. 4 pumps of Purell were placed on top of the snowball and it was lit for the image. The other source of lighting in the image (coming from the left side) comes from a light in a room next to where this photograph was taken. There were no other sources of light in the image.

The field of view for this image is about 10 inches by 7 inches. This was chosen because it allowed the snowball and flame to be imaged. If it were larger, it would lose "feeling" because the snowball and flame combination wouldn't compose most of the image. The flaming snowball was about 3 feet from the camera when the picture was taken. The camera equipment and settings are listed below.

- Camera: Nikon D90 DSLR
- Lens: Nikkor 50mm f/1.8
- Original pixel size: 4288x2848
- Image size (pixels): 4288x2848 (not cropped)
- Aperture: f/1.8
- Exposure: 1/20 sec

---

[2] Chemistry and Chemical Reactivity, Kotz, Treichel, Townsend: (p. 68)

[3] Chemistry: Principles and Practice: Reger, Goode, Ball (p. 99)

[4] Combustion Phenomena: Selected mechanisms of Flame Formation, Propagation: Jarosinski, Veyssie (p. 172)

- ISO: 2000

The image was manipulated by changing the temperature to 4900 K, adjusting the exposure by +0.42, increasing the blacks in the image by +7, adjusting the contrast by +17, adjusting the saturation by +21, using noise reduction, and adding a vignette around the image.

The image simply reveals the combustion of an alcohol but I think the idea is interesting due to the fact that it kind of fools a viewer into thinking that a snowball is on fire which is something that you don't usually see. The aspect of the image that I like is the dynamics and color of the flame. We are so used to seeing red/yellow/orange flames, that the blue flame is definitely different. I wish that I could have used a faster shutter to capture the image, but the flame just wasn't bright enough so it has a little blur to it. Also I wish I could have not had issues exporting the video for this. I think that definitely did a better job showing what I wanted to represent with this project.