Team First Image Report

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This image was taken for the Team First project. I was trying to capture the effect that metal ions have on the color of a flame. When certain compounds that contain metal ions are heated to hot enough temperatures, such as in a flame, they give off a unique spectrum of electromagnetic radiation, in other words light. I decided to try and see the effect that Potassium Chloride had on the color of a flame. To do this I covered some potassium chloride salt substitute in isopropyl alcohol and set it on fire. I mainly wanted to capture the color of the flame and how different the color is compared to just isopropyl alcohol burning.

The setup consisted of a metal baking sheet sitting on top of a balcony outside. Being in a well ventilated area, such as outside, was important as inhaling the fumes from burning chemicals is not good. While the fumes from these particular chemicals were not inherently toxic, breathing in any smoke is not good for you. The potassium chloride salt substitute was sprinkled on the pan and then covered in a small amount of isopropyl alcohol. The isopropyl alcohol was then ignited using a long lighter. The image was then captured as the isopropyl alcohol was burning. The set up is pictured below in Figure 1. The circular metal baking sheet was about 12 inches in diameter. The actual flame in the image was approximately 4 to 5 inches long.

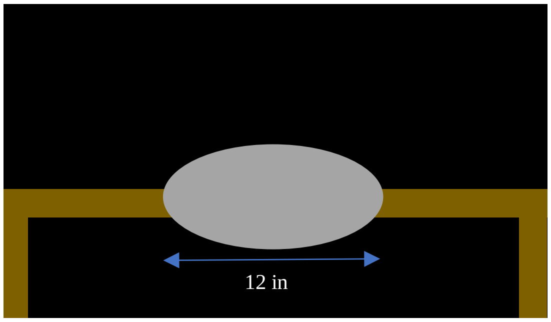

Figure 1: Apparatus Sketch

The reason why different compounds give off different colors of light when heated up is due to their electromagnetic emission spectrum. Without going into too much detail, certain elements have a certain number of electrons each in distinct energy levels around their nucleus. When these electrons are excited, or gain more energy, they are able to jump up to higher energy levels (Suplee). Then when these electrons fall back down to their lower energy, more stable energy levels they release energy in the form of photons of certain wavelengths. These energy levels and how many electrons occupy each one is all governed by the laws of quantum mechanics. Since each element has unique energy levels, they emit unique wavelengths of light when this process occurs. One way to excite the electrons of an element is to put it in a flame. Then as the electrons fall back to lower energy levels they release photons and cause the flame to change color. In this experiment potassium chloride was the compound releasing these wavelengths of light (Suplee). The emission spectrum of KCl is pictured below in Figure 2. Then in Figure 3 the relative intensity of the strongest emission lines of potassium is shown. It is important to note that the data from Figure 2 and Figure 3 is not from the same source and does not represent the same data. Figure 1 is just to have a better visualization of the emission spectrum.

Figure 2: Potassium Emission Spectrum (Barthelmy)

Intensity	Vacuum Wavelength (Å)	Spectrum
800	441.81	K II
150	465.08	K II
	469.50	K II
300	476.03	K II
1000	495.14	K II
1000 P	600.77	K II
800 P	607.93	K II
1000 P	612.62	K II

Figure 3: Strong line Emission Wavelengths of K II (Strong Lines of Potassium (K))

The relative intensities listed in Figure 3 should be used with caution, the source I got them from warned that the relative intensities vary drastically with the conditions of the experiment (Suplee). This experiment was not controlled very much at all and was more focused on the artistic aspect of capturing the color of the flame. In a lab controlled emissions test, pure potassium gives off a pale violet flame due to its emission lines around 450 nm. The flame in the image has more of a reddish orange color. This is most likely from emission lines around 600 nm which are a yellow orange color. The isopropyl alcohol definitely effected the color of the flame to some extent as well. Isopropyl alcohol on its own gives off a pale blue flame. The way the salt substitute is made or treated also could have affected the color of the flame. Lab grade potassium would have been best to achieve the purest color flame.

The flow visualization technique was to have a dark background to give more contrast to the flame. You can see the curves and dips in the flame very well against the black background. The isopropyl alcohol used was 91% and was bought from Walmart. The potassium chloride used was a salt substitute called NuSalt and was also bought from Walmart. The ingredients listed on their website are the following: "Potassium Chloride, contains less than 1% of Cream of Tartar, Silicon Dioxide, and Natural Flavor" (NuSalt). The sources of light were just the flame and the flash from my camera. It was taken at night with little other light sources illuminating the image. The image was taken about 5 or 6 inches away from the flame, almost parallel to the baking sheet,

This image was captured using a Nikon D3400. The original image dimensions are 6016 x 4016 pixels and the final image dimensions are 5363 x 2071 pixels. The ISO was 11400. An F-stop of f/22 was used and an exposure time of 1/60th of a second. A fast shutter speed was necessary as the flame was moving and changing very quickly. A high f stop was used because I wanted to capture the flame in the low light conditions and I only wanted a plane of focus, I didn't need a whole lot of depth. A high ISO was used so I could capture the flame in the low light conditions the image was captured in. Manuel focus was used with a focal length of 34 mm.

The original image, pictured below in Figure 4, was too bright with the flash used so I had to up the exposure and contrast significantly to really be able to see the sharp color and outline of the flame. I was okay with the image quality going down a bit as long as the outline of the flame was well defined.

Figure 4: Unedited Image

I really enjoy the sharp edges of the flame in the image as well as the shape it takes on. I chose to use this image mostly due to the shape of the flame; I really liked the curves and it reminded me of the beautiful Flatirons located right next to CU Boulder's campus. The physics of the flow and the color of the flame were captured well but it would have been easier to know what exactly is causing the color of the flame in a more controlled setting. However, in a more controlled setting the flame probably would not have had such a unique shape. If anything, I would like to improve the focus and reduce the editing required so the true color of the flame is not distorted at all. If given another chance, I would experiment with different compounds or having multiple compounds burning next to each other to give the viewer a better idea of how different compounds produce different colors.

Works Cited

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