Team First

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Group 9

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I. Context and Purpose

As my teammates and I researched interesting flow phenomenon, we were drawn to the concept of different elements emitting different spectra of light when ignited. Atypically colored flames are sometimes associated with science fiction or even fantastical fiction, but green, blue, and purple flames are achievable in real life. As the different materials are excited by heat, they release photons of different wavelengths, characteristic of their chemical makeup and the various orbital levels within their atomic structure. This same phenomenon is applied in atomic spectroscopy, which is used in a wide array of applications, including the means by which we can identify the materials that comprise stars, planets, and other atmospheres in our solar system. By measuring the wavelength of light emitted by something, we can know exactly the elements that comprise it without ever having to physically interact with it. This is powerful science and we wanted to capture a small part of it with “rainbow flames”.

II. Experimental Setup and Description of Physical Phenomena

In order to make this experiment possible, my teammates and I had to do some research on the various types of chemicals we would need and safety considerations for each. We used the fume hood in the basement of the ITLL in order to prevent the inhalation of fumes and create a safe environment for the flames. We used several different chemicals, including borax, calcium carbonate, potassium chloride, sodium chloride, and isopropyl alcohol. We bought all these items at a local grocery store in the form of vitamin supplements, table salt, and hand sanitizer. For my final image, we used a mixture of isopropyl alcohol (hand sanitizer), which created blue flames, and sodium chloride (table salt), which created the orange flames in a 10 inch by 10 inch metal tin. With a completely dark room, I was able to capture my final image.

You may recall from chemistry that atoms have different orbitals. When the orbital closest to the nucleus is filled with electrons, the next orbital is filled and so forth. When energy, like heat, is added, these electrons can get excited and jump up to a higher orbital. When the return to their original orbital, they release energy in the form of light. The wavelength of light is proportional to the distance the electron jumps and specific to the chemical composition of the atom.

Also shown in my final image are little trails of orange light. These are caused salt granules igniting and popping. I wanted to find out exactly how fast they are moving so that I could quantify the flow in some way. Since my shutter speed was 1/10 of a second, and after accounting for zoom and cropping, these trails were about an inch long, I was able to determine that they are moving at 10 inches per second.

III. Visualization and Lighting

In order to capture the bright colors of the flames, we kept the room entirely dark. The surface of the tin containing the fire was reflective so that it was easier to see the flame and made the image brighter.

IV. Photographic Technique

Using my Canon PowerShot S5 IS, I used the following settings, producing a 3264 pixel by 2448 pixel image:

F-Stop	f/3.5
ISO	800
Focal Length	30 mm
Max Aperture	3.625
Exposure Time	1/10 sec
Digital Zoom	1

I chose a relatively high ISO speed because the room was so dark and I wanted to let in as much light into my sensor as possible. I chose to use an exposure time of 1/10 second because, although it missed a lot of detail of a stationary flame, it managed to capture the motion of the salt particles, which I thought made the image interesting.

In post processing, I cropped the image and bumped up the color saturation and contrast so that the beautiful colors of the flame are easier to see. My original and final, edited image are shown below:

 

V. Final Thought and Future Improvements

I am pleased with my final image. I think the texture of the tin adds a lot of detail and interest. I learned a lot about light at the quantum level and the chemistry behind different colored flames. In the future, I would want to try different chemicals that produce other colors. We attempted to use borax and various salt substitutes but couldn’t manage to get vibrantly colored flames. I would also love to retake this picture with a lot of different shutter speeds to see what aspects of the flame I can capture. Overall, I am also pleased with the scale of this image and the vibrant colors.

VI. References

Reucroft S, Swain J (1999) https://www.scientificamerican.com/article/why-do-certain-elements-c/