Group 2 Report

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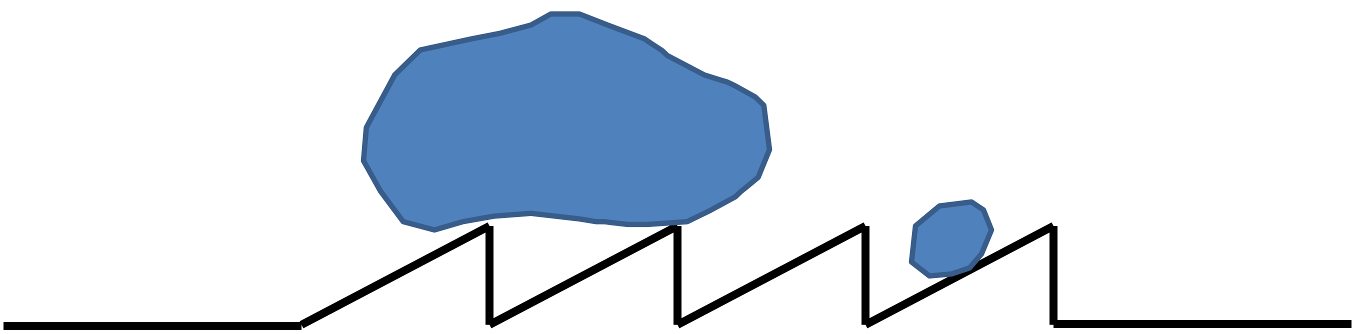
For the second group project, the team had many other extracurricular activities occupying time. Therefore, Kyle Thatcher and I separated and produced our own experiment. Some teams in the class had already experimented with the Leidenfrost phenomenon, but we had remembered seeing a video that took this one step further and wanted to reproduce the experiment for ourselves. When a water droplet is placed on a hot pan, it may evaporate rapidly or sizzle and bounce around. However, if the pan is above the Leidenfrost temperature for water, the droplet will evaporate at a much slower rate and slide around more easily that an air hockey puck. The Leidenfrost effect occurs when a water droplet falls onto a surface that is above the Leidenfrost temperature (around 380 degrees F). Because the temperature is so high, it vaporizes the bottom of the droplet and creates a vapor boundary layer between the surface and the droplet. This boundary layer not only allows for an almost frictionless interaction, but significantly reduces the heat transfer. Using this technique, we fabricated a serrated surface like the one in the diagram below and used the Leidenfrost effect to propel water droplets uphill.



We found a remnant of brass plate, 5”x 10”x 3/8”, and clamped it in the mill at a 20 degree angle to horizontal. Using a 3/8” end mill, material was removed in the z-axis (outwards) with respect to the sketch above. From peak to peak, each ridge is 1.5mm apart and 0.5mm deep. When this plate is heated beyond the Leidenfrost temperature, a pressure gradient created underneath the droplet propels it to the left. This force is strong enough to propel the droplet upwards on an angled plate, up to an angle of about 15 degrees. When the droplet encounters the smooth surface afterwards, it then begins to slide downward because the propelling force is no longer present and gravity takes over.

The droplet size had a significant effect on whether or not the propulsion force was strong enough. The droplet on the left represents a typical sized droplet relative to the ridges that would be propelled, while the one on the right is not large enough and would simply get stuck in a valley or bounce around between them like a Mexican jumping bean. If the drop of water was much larger than the one on the left, the mass of the water was too great and would not be propelled effectively in the upwards direction.

The lighting used was simply ambient fluorescent light with a flat surface behind the shot. The camera was experiencing technical difficulties during the video shoot that had to later be addressed by a camera shot. Because of the issues, the focus plane is very small. No color or contrast editing was done in post processing, but one clip is obviously slowed down to 0.25 times regular speed.

This was an extremely fun experiment to conduct and create. Many other students enjoyed playing with the apparatus while it was set up in the Durning student projects lab. I would like to experiment with other liquids in the future to see how they react to the hot surface and pressure gradient.