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Team First Report (Team #7)

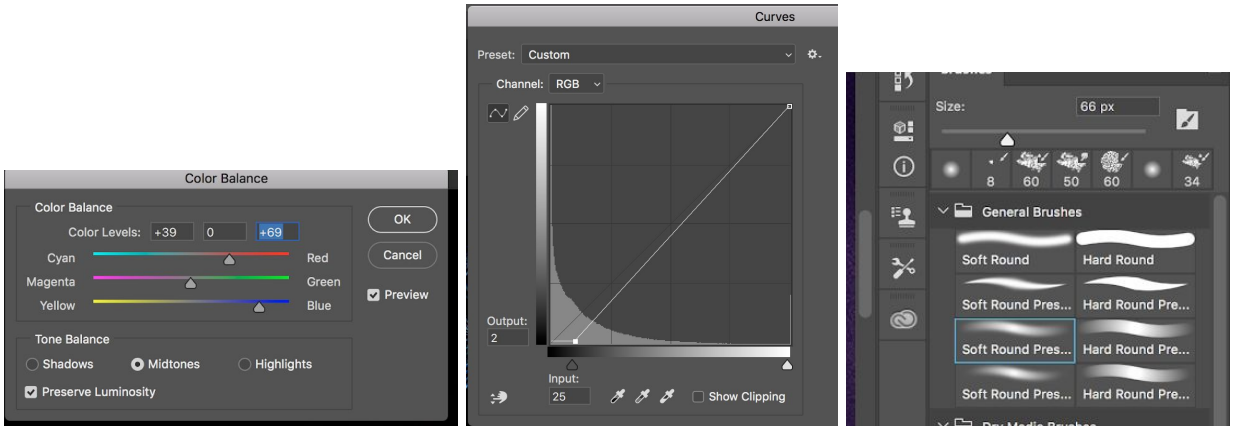
Background

This image was created for the Team First assignment in the fall of 2018 for the Flow Visualization class at CU Boulder. This project gave out team a chance to experiment with smoke as a visualization technique for fluid mechanics.

Artistic Intent and Post Processing

The intent of the image is to show flow in an interesting and unusual way. I changed the color balance to bring out a purple hue and applied a small curve and used a brush to make the background solid black. This contrast and color helps to emphasize the flow itself in a way we would not normally see it. Normally a wisp of smoke is normally not noteworthy, but this image emphasized the details of the flow.

The image is not cropped from the original version due to the interesting visual contrast of the asymmetric negative space.The original image was shot with a Nikon D610 with a Tamron AF 28-300mm lens. The focal length is 70.00 mm with an exposure of 1/100 sec; f/5.0; ISO 1100. The original image size was 6016 X 4016.



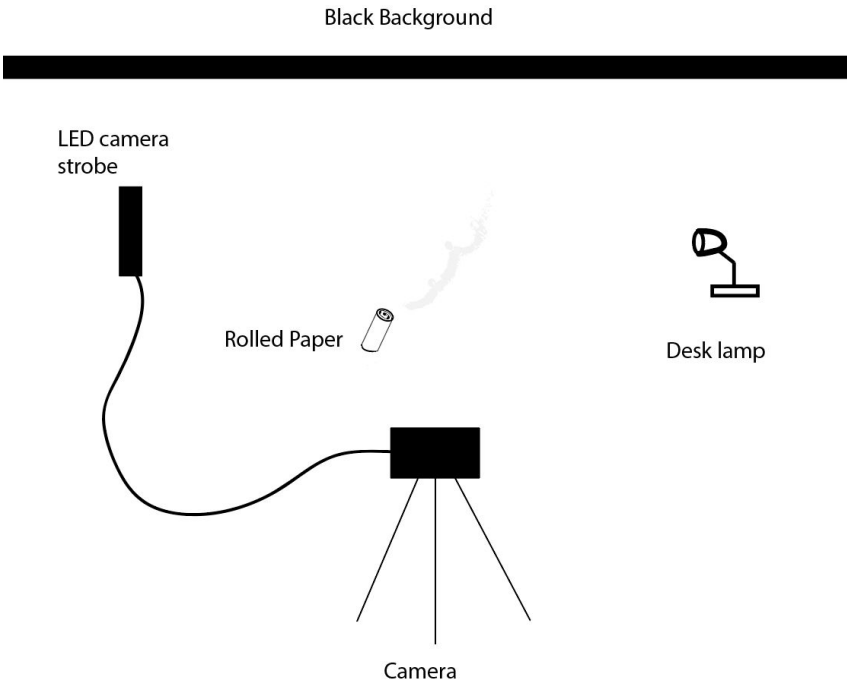
Tools used to edit image

Original Image

Final Image

Set-up

The diagram below shows the set up, which included a black backdrop, two light sources, a Nikon 6D10 camera, and rolled up paper (smoking).



Physics

This experiment demonstrated a laminar to turbulent flow. The flow of smoke is caused by the density difference between the smoke and its surroundings. The smoke has a higher temperature than the air surrounding it and a lower density. It therefore rises. The velocity of the smoke is dependent on how large the temperature difference is. This velocity can be calculated using the Reynolds number. The Reynolds number also determines if the flow will be laminar or turbulent. An increase in the Reynolds number indicates and increase in turbulence.

The Reynolds number is defined as:

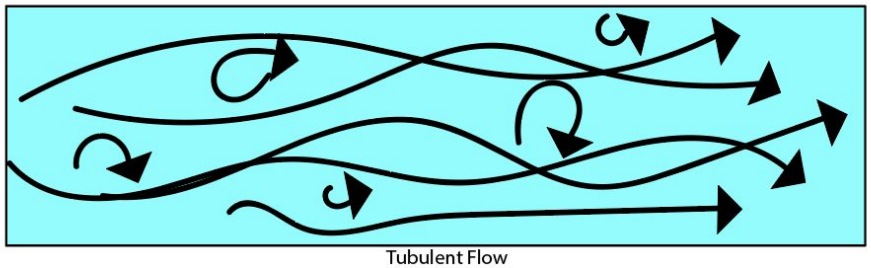
$$Re = \frac{VD}{\nu}$$

(eqn.1)

Where V is velocity (m/s), D is the characteristic length (m), and υ is kinematic velocity (m^2/s)

If the reynolds number is below 2000 the flow is laminar. The smoke is streamlined and smooth. Smoke moves in a straight line and layers flow over one another without mixing. In this experiment, this occurred near the burning paper, which is not shown in this image. If the reynolds number is above 3500 the flow is turbulent. This is what is observed in the majority of this photo, as we can see the smoke moves in unpredictable and more chaotic ways. Between these values, the flow is in transition and is unstable (1). This is seen near the bottom of the image, where the flow isn't completely laminar but clear wisps of smoke are easily seen.

Laminar Flow



Tubulent Flow

1. “Definition of Reynolds Number.” *Nuclear Power*, www.nuclear-power.net/nuclear-engineering/fluid-dynamics/reynolds-number/.