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Piezoelectricity and Hydropower Research

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Piezoelectricity and Hydropower

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Motivation

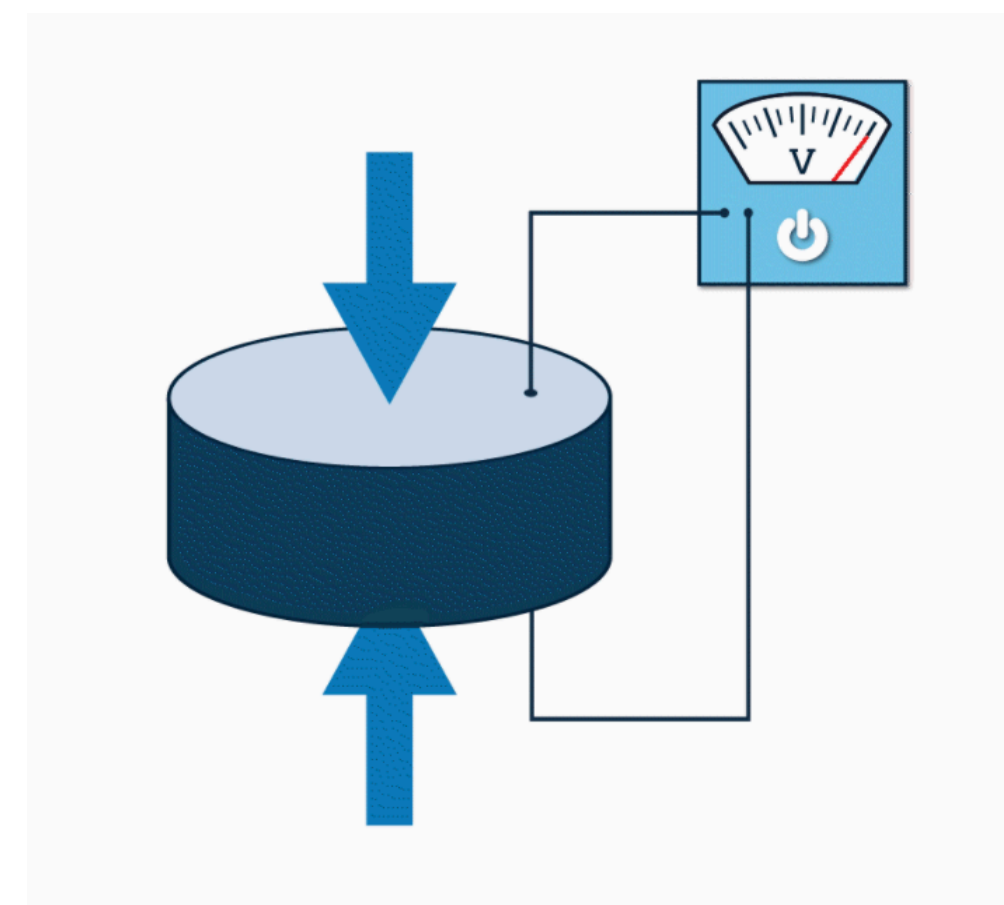
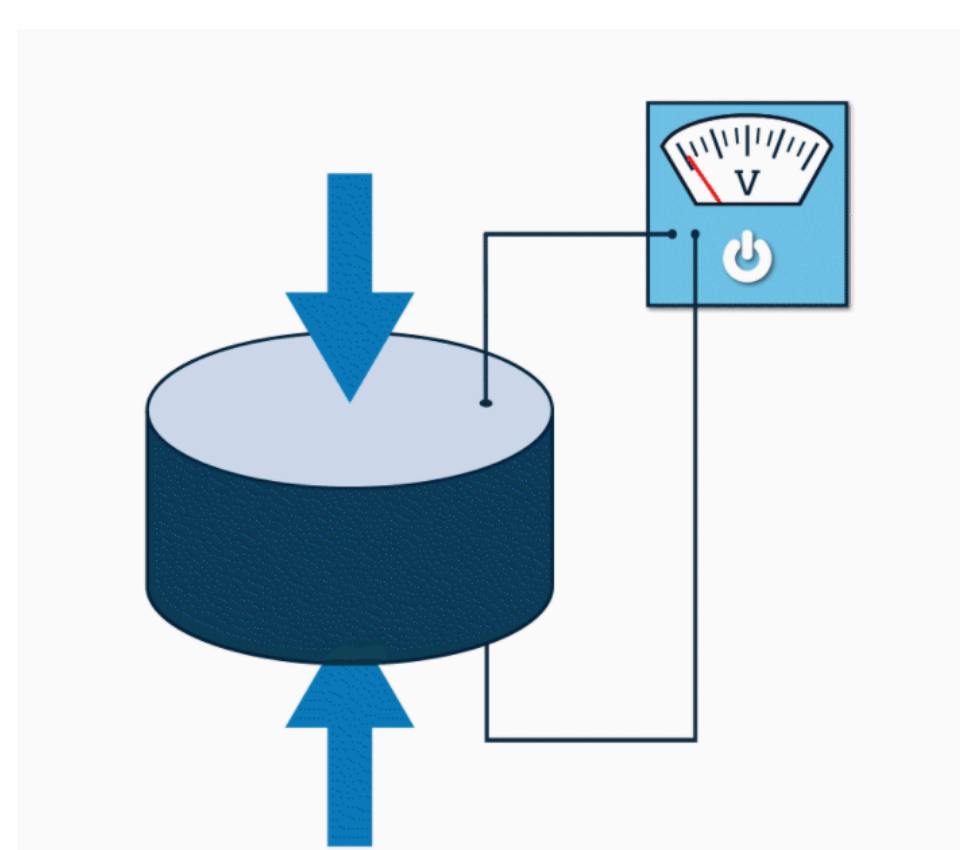
The primary focus of my research project is to find a new way to convert energy from the flow of water out of a household faucet into other sources. We used piezoelectric crystals made from ceramic disks and applied a force that resulted in the transfer of mechanical energy to electrical energy. I define piezoelectricity as an electric charge that accumulates in some solid materials, like quartz or ceramic, when mechanical stress is applied. The overall goal is to find a new way to harness wasted energy.

Background

➤ Piezoelectric Effect is shown in the images below. As a force or pressure is applied to the crystal a resulting voltage value appears.



➤ When mechanical stress is applied to the crystal a charge separation occurs which causes the piezoelectric effect.



➤ Using the two equations below we were able to determine the velocity of the water coming out of a faucet at different heights. From this we were able to determine the force as well because the function of velocity is directly proportion to that of force.

From this we find Velocity at the top:

$$\frac{\Delta M}{\Delta t} = \rho AV_T V$$

Next, we find the Velocity at the bottom:

$$\sqrt{2gh + V_T^2} = V_B$$

Find the force:

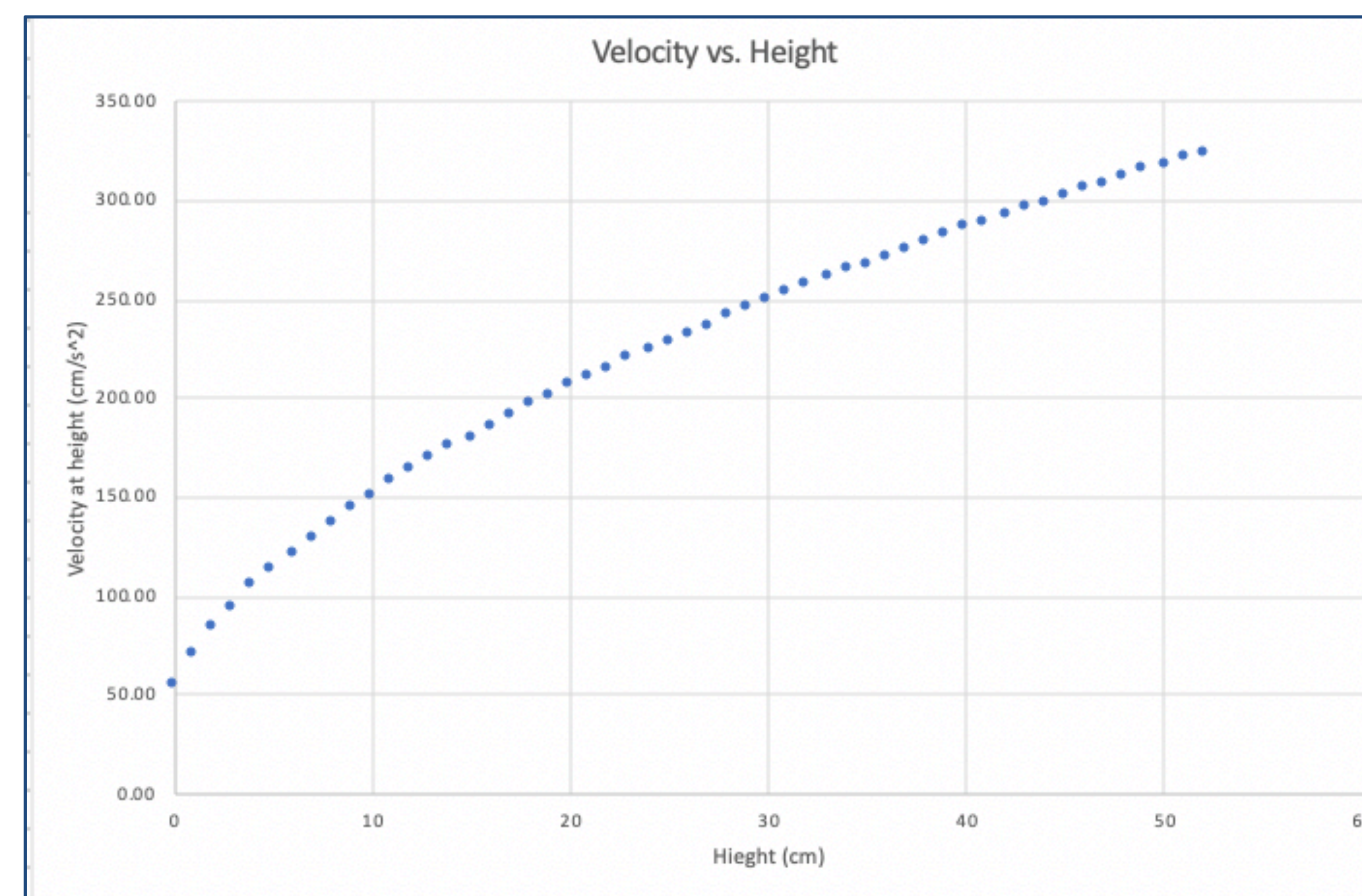
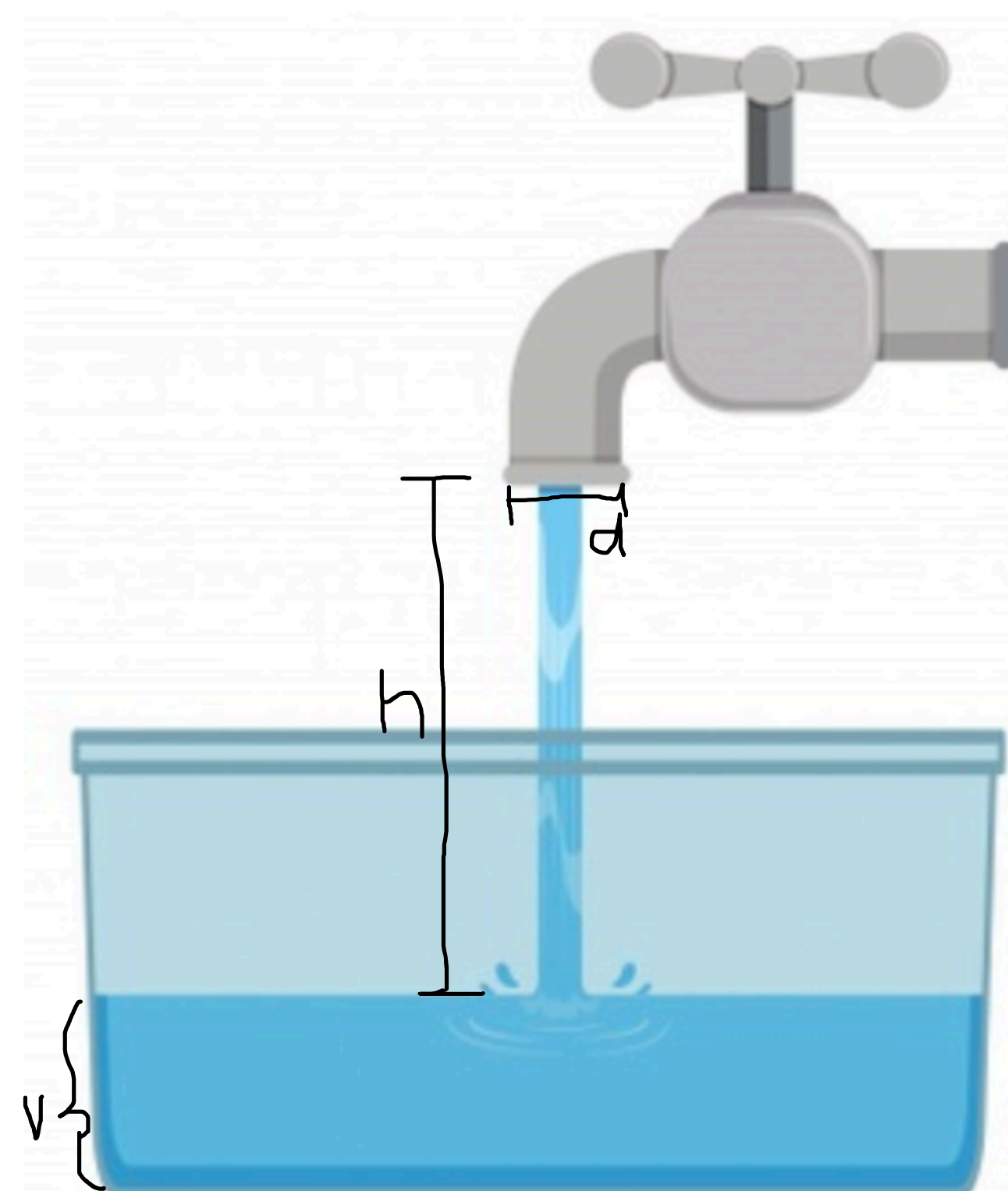
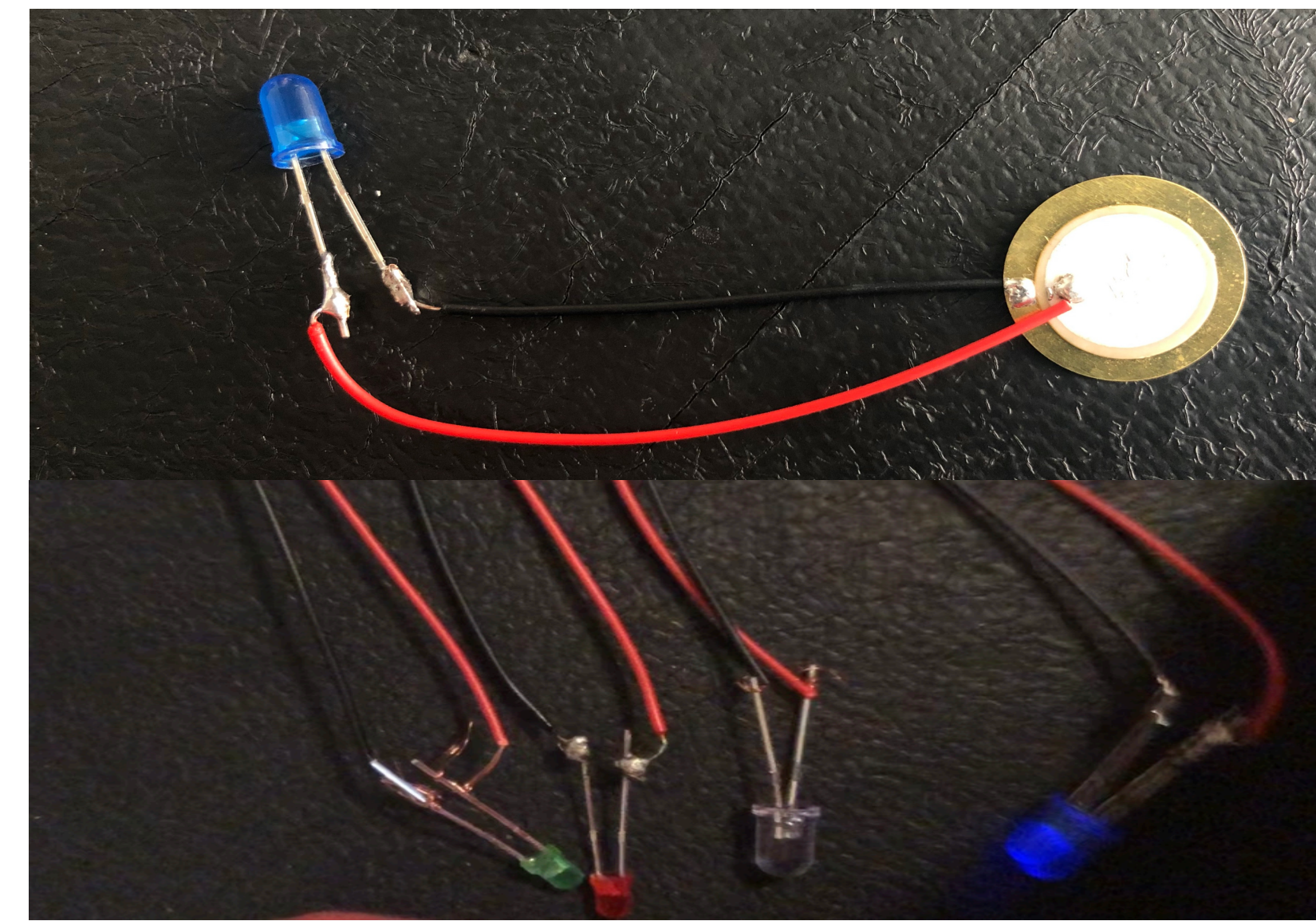
$$F = V_B * \frac{\Delta M}{\Delta t}$$

Piezoelectric Crystal Results

- Using a solid rod we struck the base of the piezoelectric crystal
- Measure voltage with Digital Multimeter
- I was able to measure the voltage difference measured from when the crystal was struck that ultimately flowed into diode
- The diodes lit up when the mechanical energy transferred to electrical energy and flow through the diode

	Red	Yellow	Green	Blue	White
Single Crystal	16.79 volts	18.34 volts	18.01	19.89 volts	17.81 volts

This table shows the results of the single crystal attached to a different colored LEDs.



➤ Using the equations to the left with measurements from the stream of water from the faucet I was able to calculate the velocity per height and then the force per height.

➤ This plot demonstrates the directly proportional relationship between the velocity and height. Then we found force due to a stream of water because it is directly proportional to the velocity, so we used the velocity at the bottom at each height measurement.

Analysis and Conclusions

- Using a soldering iron I developed a strong connection between the LEDs and crystals allowing the mechanical energy applied to light up the LEDs
- Trying to create a higher voltage by placing the crystals in series or parallel.
- Due to such a small force calculated from the water we must find a way to make crystals more sensitive
- Successfully lit up LED and produced electricity without the aid of an outside power source or battery

Further Research

- Stack crystals to amplify the signal and create electric energy with a smaller force
- Ultimately, we must create a large enough stack that the small force in the water stress is sufficient to light up LED
- Plan to continue over summer 2020
 - Continue to harness wasted energy
 - Using piezo crystals create turbine to aid while using wasted water
 - Plan to create other mechanisms to convert energy from mechanical to electric without the use of an outside power source or battery

