Investigating the Torricelli law

Background: An Arduino UNO is an extremely powerful microcontroller which can be programmed to carry out many different operations thanks to its plethora of compatible components. One of these components MPX5010DP is a pressure sensor which can be used to measure the variation in liquid head over an amount of time[1]. This exact method is used to investigate and verify Torricelli's law a description of fluid discovered by Evangelista Torricelli, in 1643[2] which found that *liquid drains at a rate proportional to the square root of the liquid height above the hole*[1].

Objectives:

- Set up Arduino system which can measure the change in liquid head over time.
- Verify if Torricelli's law holds true.
- Explore Torricelli's law using alternate liquids and viscosities.
- Consider a real world application for the system created and the impact it may have.

Parts List:

Parts Obtained:	Parts Needed:
Arduino UNO	Water
Pressure Sensor (MPX5010GP)	Alternate Liquid
Wiring	Viscous Liquid
USB cable	
Liquid container	
Breadboard	
Parafilm	
Narrow acrylic tube (3mm ID)	
Plastic drain tube (6mm ID)	
Wooden stick	
Blu Tack	
Cable ties	
Resistor	
Capacitor	

Work packages with key tasks:

Build a circuit connecting an MPX5010GP Pressure Sensor to an Arduino micro-controller, using wiring and a breadboard. The Arduino will be powered through an external computer using a USB cable, allowing us to adjust the Arduino coding. The Pressure Sensor has two ports P1 and P2, P1 will be submerged into the liquid where the water is draining out and P2 will be exposed to the air pressure.

Arduino uses the language C++, we will use the code provided to get the experiment running. Once that is complete we will attempt to create a GUI which will make the process more streamlined.

We will measure the pressure difference for multiple liquids and attempt to graph each of them in real time using the Arduino COM3 and write it to a csv file.

Finally once we have all of our data, we should be able to analyse it and conclude whether or not Torricelli's law held true for each of the liquids used.

Expected outcomes and impacts:

Societal impacts: Some industries require the removal of toxic or harmful waste to be drained automatically, in a way in which no human comes into contact with the toxic liquids and fumes. A piece of equipment such as this one may be useful in displaying whether or not the harmful substances have been drained yet and if it is safe for a human to come collect the container. Some companies such as WIKA produce submersible pressure sensors for these exact scenarios[3]

Health and Safety: Anytime you are working with electronic components that measure something related to liquid it is important to be extremely careful. Water is an excellent conductor of electricity and it is important to make sure none of it gets onto any of the PCB or wires and causes a short circuit. With water and electricity there is always a risk of electrical shock or slipping, it is important that we minimise these risks as much as we possibly can.

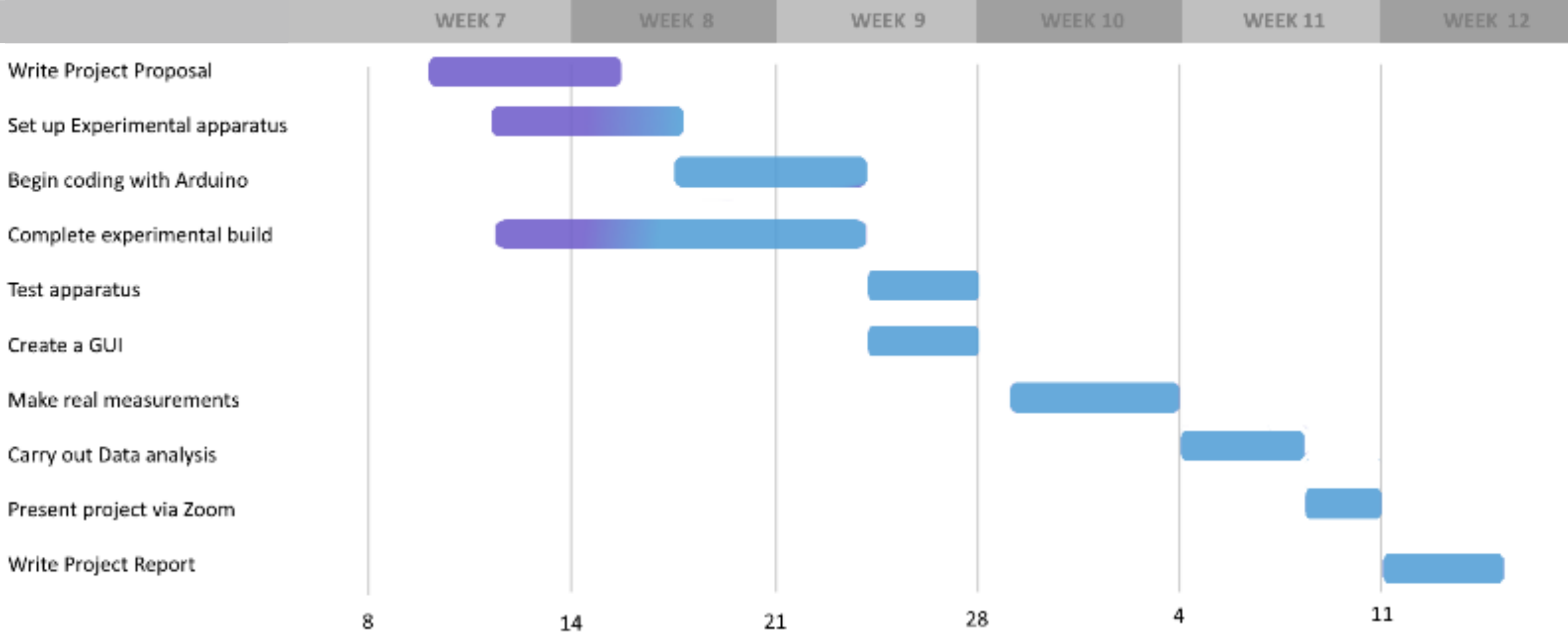
Scientific impacts Using this method to verify Torricelli's law gives us the freedom to use different types of liquid, not just water. We could potentially discover that some liquids do not obey Torricelli's law and perhaps the data extracted from the experiment and the characteristics of the liquid will give us insight into why.

References:

[1] Keith Atkin, "Investigating the Torricelli law using a pressure sensor with the Arduino and MakerPlot" Nov. 2018, https://iopscience.iop.org/article/10.1088/1361-6552/aad680

[2] Azeem Iqbal, "Dynamics of water discharge from a cylinder (2.5 Torricelli's law)" Apr. 2016, https://www.physlab.org/wp-content/uploads/2016/04/Manual_v3.compressed.pdf

[3] WIKA, "Intrinsically safe submersible pressure transmitter For applications in hazardous areas Model IL-10" Nov. 2018,
https://www.wika.com/media/20__datasheets/3fuellstand_3/03pegelsonden_2/ds_pe8123_en_co.pdf


WEEK 7
WEEK 8
WEEK 9
WEEK 10
WEEK 11
WEEK 12
Write Project Proposal
Set up Experimental apparatus
Begin coding with Arduino
Complete experimental build
Test apparatus
Create a GUI
Make real measurements
Carry out Data analysis
Present project via Zoom
Write Project Report
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