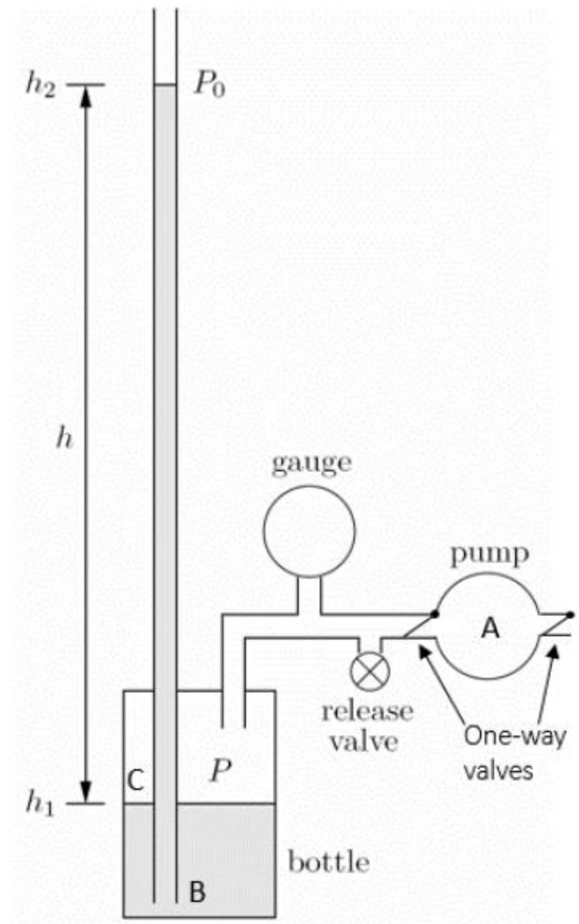
Fluids Lab

In this lab you will explore the idea of pressure and you will use this idea to measure the density of the colored liquid you can see in the laboratory apparatus. There are several different liquids in several colors! To get oriented, look at the drawing below and compare it to the apparatus. The pump is the black rubber bulb that you can squeeze to increase the pressure P indicated by the gauge in the air region between point A and the surface of the liquid in the drawing. Note that the total pressure P in the pressurized air space on the diagram is $P = P_g + P_0$, where P_g is the gauge pressure reading and where P_0 is atmospheric pressure. It will be helpful to remember that pressure is force divided by area, or $F = P A$, and that if the pressure at the surface of a liquid is P, then the pressure a distance h below the surface is $P + \varrho gh$, and that if the pressure deep in a liquid is P, then the pressure at a distance h higher up in the liquid is $P - \varrho gh$, where ϱ is the mass density of the liquid (kg/m^3) and where g is the acceleration caused by gravity, $g = 9.8\ m/s^2$.

Prelab Prompt: In the space below, write a short paragraph explaining how the pressures at points A, B, and C compare as you pressurize the bulb in order to make the liquid go up in the tall tube between h_1 and h_2.



Based on Experiment 1,PH123@ BYU https://youtu.be/nMBnYFcM22c?si=-wdQLa7Yce0RPxkS

Procedure

Begin by making the pressure gauge read 0 by opening the air release valve (turn the black knob on the brass fitting counterclockwise). Then close the valve and start to pump the bulb. Keep pumping until the liquid is at a reasonable height that you can measure with the attached 2-meter stick. Be careful–don't make a mess. Once the liquid has been raised, and maintains a steady height, measure the heights h_1 and h_2 as shown on the drawing and record them below along with the gauge pressure Pg.   Repeat this at six different gauge pressures.

Remember that the gauge doesn't read the absolute pressure of the air between the bottle and the pump–it gives the pressure above the atmospheric pressure P_0. Also note that the gauge reads in units of oz/ in^2, so you will need to convert units. (1 oz=0.278 N, 1 in=0.0254 m)

Measured Data		
Surface of the Liquid in the Jar: h_1 (cm)	Surface of the Liquid in the Tube: h_2 (cm)	Gauge pressure: P_g (oz/in^2)

Example calculation and conversion for $h=h_2-h_1$ into meters

Converted Data to be used in the Chart	
Height of the column: $h = h_2-h_1$ (m)	Gauge Pressure: Pg (N/m^2)

Example conversion for Pg into N/m^2

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Data Analysis

1. **Plot the data:** Graph the converted gauge pressure (Pg) on the y-axis against the height of the column (h) on the x-axis. The data points should form a roughly straight line.
2. **Perform linear regression:** Use a graphing tool or software to perform a linear fit (best-fit line) to the data points. The equation of this line will be in the form

$$y = mx + b$$

where m is the slope and b is the y-intercept. The y-intercept should be close to zero, confirming gauge pressure at the surface is zero. The slope will be used in the calculation below. Record your fit equation and your R^2 value.

Equation: y=__________________________x+_____________

R^2=____________________

3. **Determine the slope:** Record the value of the slope (m) from the linear regression analysis. The units of the slope should be $(N/m^2)/m$

m=______________________________

4. **Calculate the density:** Divide the slope of the graph by the local acceleration due to gravity ($g \approx 9.8 m/s^2$) to calculate the density of the fluid (ρ=Slope/g). The resulting density will be in kg/m^3.

Fluid Color	Density Result

Discussion and Conclusion

Based on Experiment 1,PH123@ BYU https://youtu.be/nMBnYFcM22c?si=-wdQLa7Yce0RPxkS

In the space below, compare the calculated density to known values for common liquids (e.g., water is ≈ 1000kg/m^3 at 4∘C) and discuss sources of experimental error, such as potential measurement inaccuracies or temperature variations affecting fluid properties.

Fluid	**Density (kg/m^3)**
Corn Syrup	1400
Glycerin	1260
Ethelyn Glycol	1113
Salt Water	1025
Water	1000
Canola Oil	915
Olive Oil	900
Baby Oil	830