Law of Hydrostatics Study Aid

MECH-322 Fluid Mechanics

"Manometry, Manometry, Manometry!!! Learn it at the beginning, because you will still be using it the exact same way all the way through the final (step). Geometry is irrelevant, if you now (apply) the process to solve the type of problem that is presented, and follow the path. If you don't know the definitions, it is improbable that you will be able to define the problem. Define the problem & develop the path of attack, BEFORE you start randomly writing down equations."

Fall 2023 MECH-322 Fluid Mechanics Student


Follow the path. There is no other way. Take the time to solve problems on your own time and truly TRY to grasp the concepts. Attending lectures without practice will not be enough.
MECH-322 Fluids Student, FALL 2021

FLUID STATICS-LAW OF HYDROSTATICS

$$\frac{dP}{dz} = \gamma \quad g \downarrow z \downarrow$$

Incompressible + No Shear Stress

POINT-TO-POINT METHOD

$$P_A + \Delta P_{A-B} = P_B$$

FOLLOW THE PATH

FIND "h".

ROAD MAP

Identify and label various elevation levels associated with different fluids and understanding Pascal's Law

Identify Starting Point and Ending Point

Identify any "MISSING" dimensions from Start Point to End Point

Transverse circuit from Start Point and Apply POINT-TO-POINT method for Law of Hydrostatics

Solve for unknown

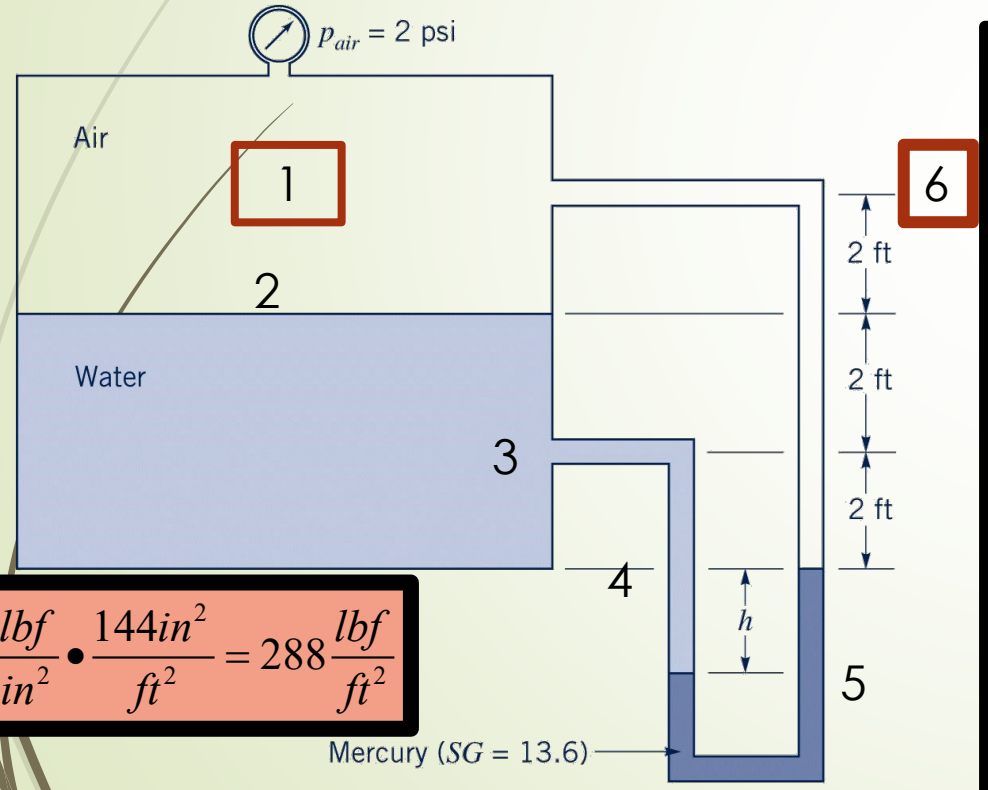


Figure P2.36

Problem 2-36 ED7

$$p_{air} = 2\frac{lbf}{in^2} \bullet \frac{144in^2}{ft^2} = 288\frac{lbf}{ft^2}$$

START 1, END 6

$$P_1 + \gamma_{air}\,2' + \gamma_{H20}(4' + h) - \gamma_{hg}h - \gamma_{air}\,6' = P_6$$

$$h = \frac{P_1 - P_6 + \gamma_{air}\,2' + \gamma_{H20}\,4' - \gamma_{air}\,6'}{\gamma_{hg} - \gamma_{H20}}$$

$$h = \frac{P_1 - P_6}{\gamma_{hg} - \gamma_{H20}} + \frac{4\gamma_{air}}{\gamma_{hg} - \gamma_{H20}} + \frac{4'\gamma_{H20}}{\gamma_{hg} - \gamma_{H20}}$$

$$h = 0 + \approx 0 + \frac{4'}{S_{g_{hg}} - 1} \rightarrow \text{Parametric Equation for "h"}$$

$$h = \frac{4'}{13.55 - 1} = 0.3187'$$

$$S_g = \frac{\gamma_f}{\gamma_{H20}}$$

FIND "Δh".

ROAD MAP

Identify and label various elevation levels associated with different fluids and understanding Pascal's Law.

Identify Starting Point and Ending Point.

Identify any "MISSING" dimensions from Start Point to End Point, ΔS.

Transverse circuit from Start Point and Apply POINT-TO-POINT method for Law of Hydrostatics

Solve for unknown.

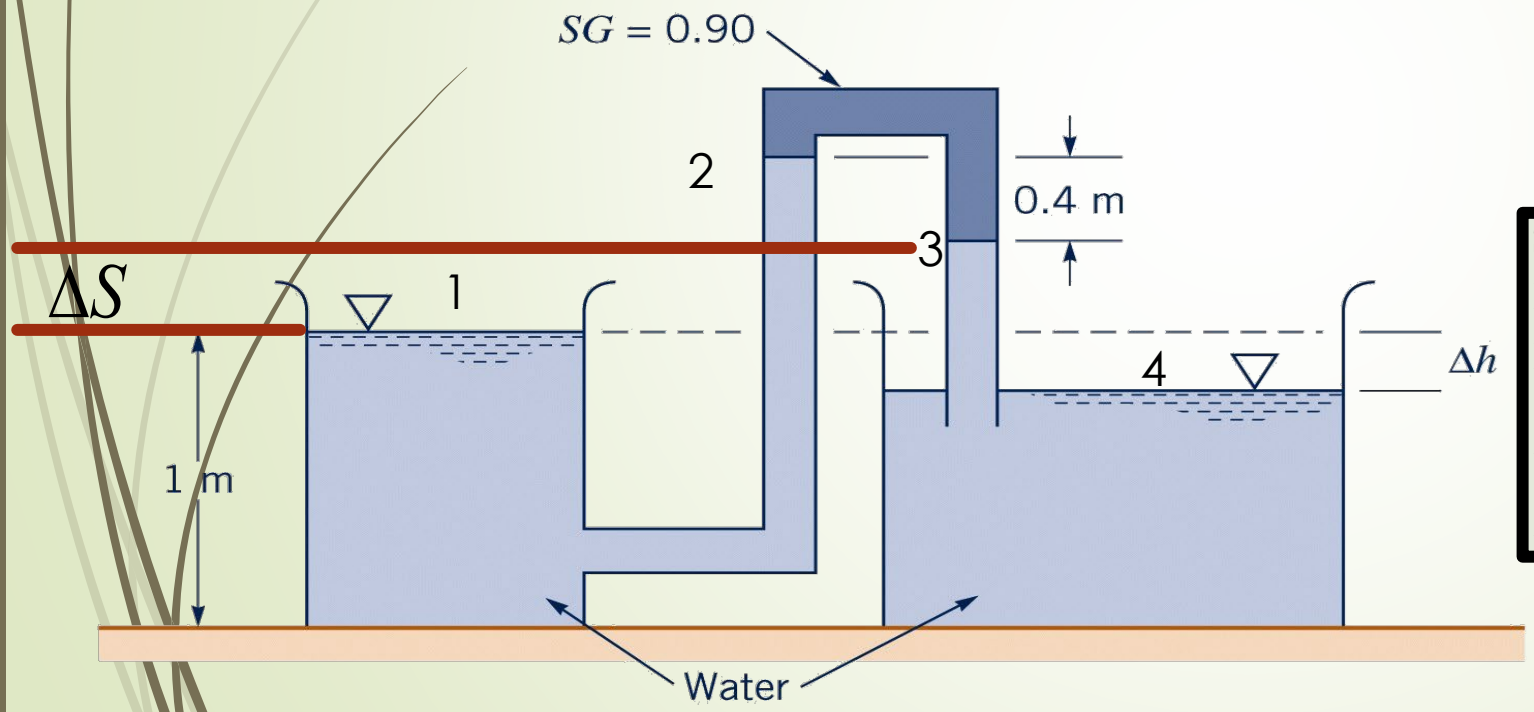


Figure P2.47

START 1, END 4

$$P_1 - \cancel{\Delta S \gamma_{H20}} - 0.4m\gamma_{H20} + 0.4\gamma_f + (\cancel{\Delta S} + \Delta h)\gamma_{H20} = P_4$$

$$P_1 = P_4 = 0\text{gauge}$$

$$\Delta h = \frac{0.4m(\gamma_{H20} - \gamma_f)}{\gamma_{H20}} = 0.4m(1 - S_{g_f}) \rightarrow \text{Parametic Equation}$$

$$\Delta h = 0.4m(1 - 0.90)$$

Problem 2.47 ED8

A U Tube manometer is connected to a closed tank with air and water as shown. The air above water is pressurized at 16 psia. Determine the reading on the gauge if the differential manometer reading is 4ft. ***Neglect weight of air above water since it is much, much less than weight of water.***

LAW OF HYDROSTATICS

PROB. 2.37

START: 0, END:3

$$P_0 \pm \Delta P = P_3 \rightarrow (P_1 = P_2, \text{negect air weight})$$

$$P_0 + \gamma_m 4\,ft + \gamma_{h20} 2\,ft = P_3$$

$$\overbrace{\left(16\frac{lb_f}{in^2} - 14.696\frac{lb_f}{in^2}\right)}^{P_{GAUGE}} \frac{144in^2}{ft^2} + 90\frac{lbf}{ft^3}4\,ft + 62.4\frac{lbf}{ft^3}2\,ft = P_3[\frac{lbf}{ft^2}]$$

$$672.58\frac{lbf}{ft^2} = P_3[\frac{lbf}{ft^2}] \rightarrow GAUGE$$

$$\left(672.58\frac{lbf}{ft^2}\frac{1\,ft^2}{144in^2}\right)[psig] = 4.671[psig] = P_3[psig]$$

$$4.671[psig] + 14.696\,psia = 19.4[psia] = P_3[psia]$$

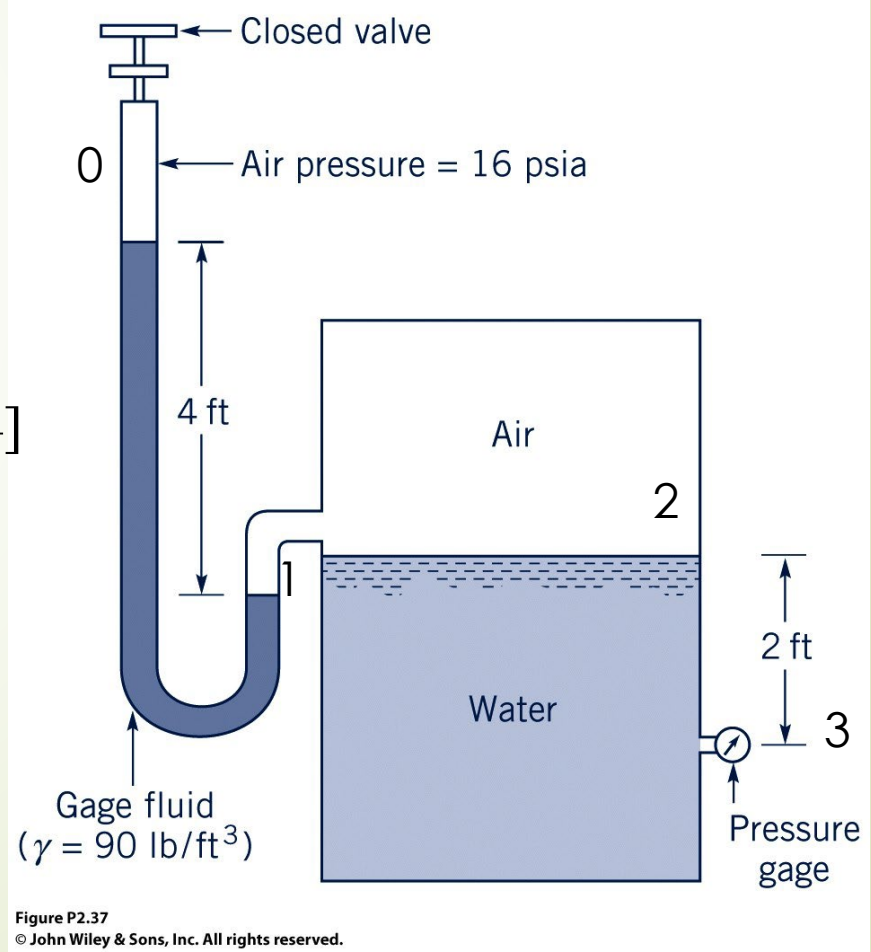
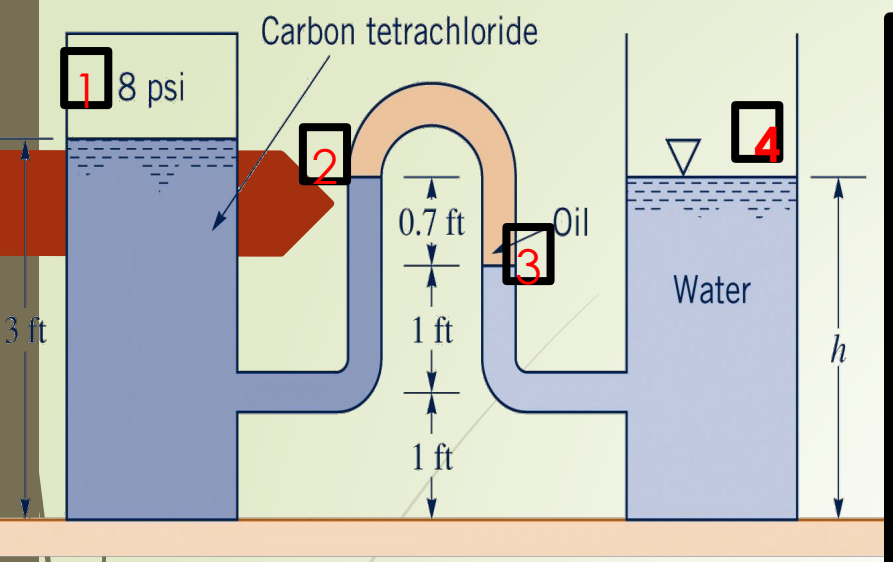


Figure P2.37



FIND h Parametric Expression & Check Units

Starting: 1, Ending Point 4

$$P_1 - \gamma_{TC}(3-2.7)\,ft + \gamma_{OIL}(0.7\,ft) - \gamma_{H20}(h-2)\,ft = P_4$$

$$h = \frac{P_1 - P_4 - \gamma_{TC}(3-2.7)\,ft + \gamma_{OIL}(0.7\,ft) - \gamma_{H20}2\,ft}{\gamma_{H20}} \rightarrow \text{Parametric Expression}$$

$$P_1\left[\frac{lbf}{ft^2}\right] = 8\frac{lbs}{in^2}\bullet\frac{144in^2}{ft^2} = 1152\left[\frac{lbf}{ft^2}\right]$$

$$P_4\left[\frac{lbf}{ft^2}\right] = 0\text{gage}\left[\frac{lbf}{ft^2}\right] \rightarrow \text{OPEN to ATM}$$

$$\gamma_{TC}\left[\frac{lbf}{ft^2}\right] = 99.5\left[\frac{lbf}{ft^3}\right]$$

$$h[ft] = \left\{\frac{1152\left[\frac{lbf}{ft^2}\right] - 0\left[\frac{lbf}{ft^2}\right] - 99.5\left[\frac{lbf}{ft^3}\right](0.30)\,ft + (0.8\bullet\gamma_{H20})(0.7\,ft) - \gamma_{H20}2\,ft}{62.4\left[\frac{lbf}{ft^3}\right]}\right\}[ft]$$

Question: How can one check units without the PARAMETRIC EXPRESSION?

- **NOTE:**

- **The application of HYDROSTATICS is a simple equation.**

- **But the real work is in the UNDERSTANDING of the problem statement, definitions, assumptions, and interpretation of the execution of the simple equation.**

- **To EXECUTE the PATH, requires PRACTICE.**

While I struggled in the class at first because it had new way of lecture structure and overall class structure, I do believe it enhanced my skills with regards to critical thinking and ability to solve problems. I was used to more specific equations that are used on certain questions so following the path and working every problem in the same way took some adjustment.

MECH-322 Fluids Student, Fall 2021