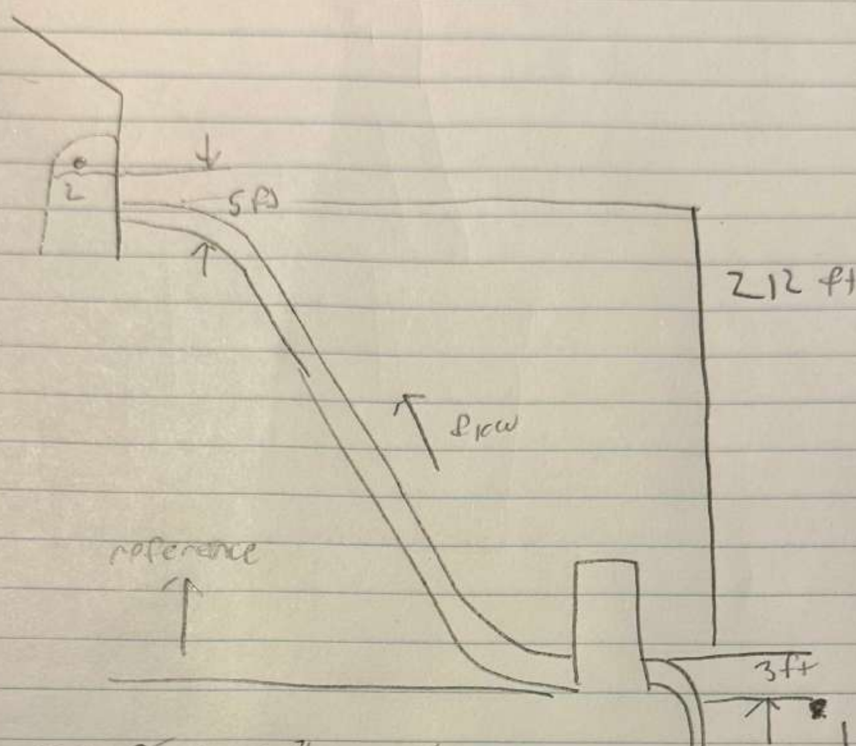
Fluid Mechanics HW 1.3 Ben Smithscn

7.42



$$h_A = \frac{p_2 - \cancel{p_1}}{\gamma} + \frac{\cancel{v_2^2 - v_1^2}}{2g} + \cancel{z_2} - z_1 + h_{L12}$$

$$h_A = \frac{p_2}{\gamma} + z_2 + h_{L12}$$

$$P_A = 624\ \frac{lb}{ft^3} \cdot 0.089\ \frac{ft^3}{s} \cdot 304.73\ ft$$

$$P_A = 169235\ lb \cdot ft/s$$

$$1\ Hp = 550\ lb \cdot ft/s$$

$$\boxed{P_A = 3.077\ Hp}$$

Power Pump

$$P\ (0.85 \cdot 9810 \frac{N}{m^3}) \cdot 0.014 \frac{m^3}{s} \cdot 117.64\ m$$

$$\boxed{P = 13.733\ KW}$$

0 kPa gage

$$\frac{\cancel{P_1}^{0}}{\gamma} + \frac{\cancel{V_1^2}^{0}}{2g} + \cancel{Z_1}^{0} = \frac{P_3}{\gamma} + \frac{V_3^2}{2g} + Z_3 + h_{L\,13}$$

$$\frac{P_3}{\gamma} \quad V_3 = \frac{Q}{A_3} \qquad A_3 - \text{back of the book} = 3.09 \cdot 10^{-3}\ m^2$$

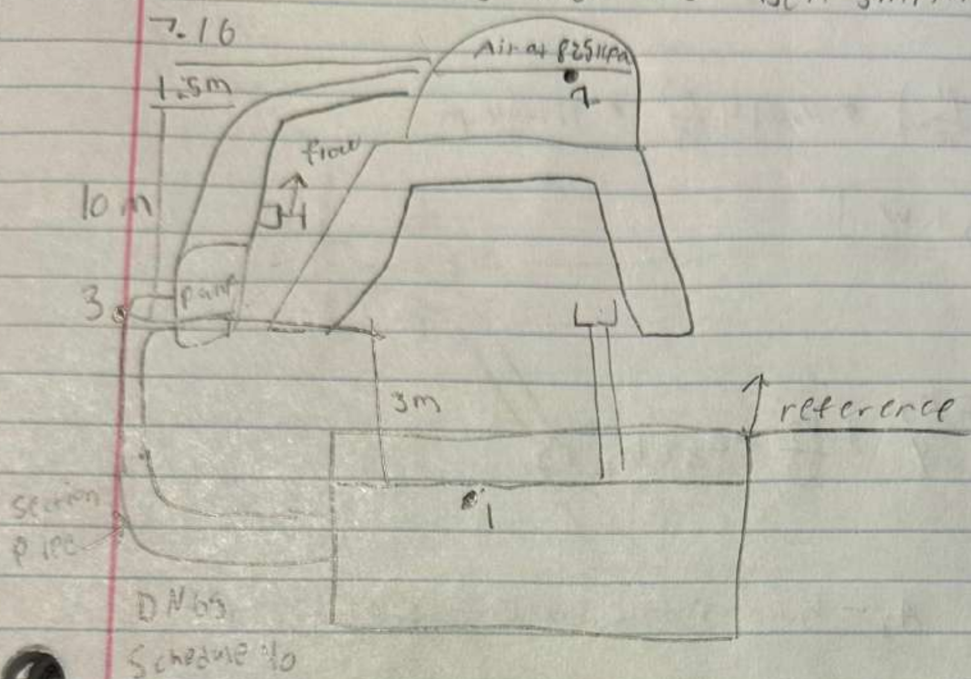
$$V_3 = \frac{0.014\ m^3/s}{3.09 \cdot 10^{-3}\ m^2} = 4.531\ m/s$$

$$P_3 = (0.85 \cdot 9810 \frac{N}{m^3}) \left(- \frac{(4.531 \frac{m}{s})^2}{2 \cdot 9.81 \frac{m}{s^2}} - 3m - 1.4m \right)$$

$$\boxed{P_3 = -45.41\ kPa}$$

Fluid Mechanics HW 1.3 Ben Smithson

7.16



sg oil = 0.85

Q = 840L/min = 0.014 m^3/s

h_L = 4.2

h_L suction = 1.4 m

bernoulli's $h_a + \frac{p_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_{L12}$

$P = \gamma Q h_A$

$h_A = \frac{p_2 - \cancel{p_1}^{0}}{\gamma} + \frac{\cancel{v_2^2}^{0} - \cancel{v_1^2}^{0}}{2g} + z_2 - \cancel{z_1}^{0} + h_{L12}$

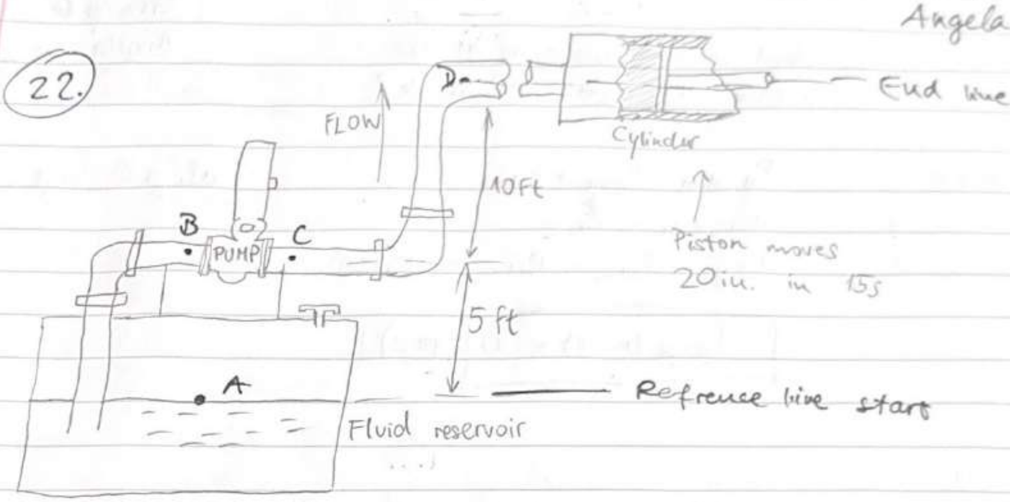
$h_A = \frac{p_2}{\gamma} + z_2 + h_{L12}$

$h_A = \frac{825 \text{ kPa}}{0.85 \cdot 9810 \frac{N}{m^3}} + 14.5m + 4.2m = 117.64 \text{ m}$

HW 1.3

02/01/2024
Angela Sicaja

22.



oil $sg = 0.9$
cylinder inside $D = 5\,in$
$t = 5s$
$F = 11\,000\,lb$
$E\ loss = 11.5\ lb\text{-}ft/lb$

$$A_{cylinder} = \frac{\pi d^2}{4} = \frac{\pi (5)^2}{4} = 19.64\,in^2$$

a) $Q = AV$

$$V = \frac{Distance}{time} \Rightarrow Q = \frac{A_{cyl.} \cdot L}{t} = \frac{\left(19.64\,in^2 \cdot \left(\frac{1ft^2}{144in^2}\right)\right) \cdot \left(20in \cdot \frac{1\,ft}{12in}\right)}{15s}$$

$$\boxed{Q = 0.0152\ ft^3/s}$$

b) $P_{cyl} = \frac{F}{A_{cyl}} = \frac{11\,000 \text{ lb}}{19.64 \text{ in}^2} \cdot \left(\frac{144 \text{ in}^2}{1 \text{ ft}^2}\right)$

$$\boxed{P_{cyl} = 80\,672.3 \text{ lb/ft}^2}$$

c) $v_c = \frac{Q}{A_c} = \frac{0.0152 \text{ ft}^3/\text{s}}{0.000976 \text{ ft}^2} = 15.52 \text{ ft/s}$

$v_B = v_c = 15.52 \text{ ft/s}$

$v_D = \frac{L}{t} = \frac{20 \text{ in}}{15 \text{ s}} \cdot \left(\frac{1 \text{ ft}}{12 \text{ in}}\right) = 0.1111 \text{ ft/s}$

$\gamma_{oil} = sg(\gamma_{H_2O}) = 0.90(62.4 \text{ lb/ft}^3)$

$\gamma_{oil} = 56.16 \text{ lb/ft}^3$

$$\frac{P_c}{\gamma_{oil}} + \frac{v_c^2}{2g} + \cancel{z_c} - h_{LD} = \frac{P_D}{\gamma_{oil}} + \frac{v_D^2}{2g} + z_D$$

$$\frac{P_c}{\gamma_{oil}} = \frac{P_D}{\gamma_{oil}} + \frac{v_D^2}{2g} + z_D - \frac{v_c^2}{2g} - z_c + h_{LD}$$

$$P_c = P_{cyl} + \gamma_{oil}\left[\left(\frac{v_D^2 - v_c^2}{2g}\right) + (z_D - \cancel{z_c}) + h_{LD}\right]$$

$$P_c = 80\,672.3 + 56.16\left[\left(\frac{0.1111^2 - 15.52^2}{2(32.2)}\right) + 10 + 35\right]$$

$$\boxed{P_c = 82\,989.43 \text{ lb/ft}^2}$$

d) $\frac{P_A}{\gamma_{oil}} + \frac{v_A^2}{2g} + z_A - h_{LS} = \frac{P_B}{\gamma_{oil}} + \frac{v_B^2}{2g} + z_B$

$z_A - h_{LS} = \frac{P_B}{\gamma_{oil}} + \frac{v_B^2}{2g} + z_B$

$\frac{P_B}{\gamma_{oil}} = z_A - h_{LS} - \frac{v_B^2}{2g} - z_B$

$P_B = \gamma_{oil}\left[(z_A - z_B) - \frac{v_B^2}{2g} - h_{LS}\right]$

$P_B = 56.16\left[(-5-0) - \frac{(15.52)^2}{2(32.2)} - 11.5\right]$

$\boxed{P_B = -1136.69 \text{ lb/ft}^2}$

e) $\frac{P_A}{\gamma_{oil}} + \frac{v_A^2}{2g} + z_A + h_A - h_{LS} - h_{LD} = \frac{P_D}{\gamma_{oil}} + \frac{v_D^2}{2g} + z_D$

$h_A = \frac{P_{cyl}}{\gamma_{oil}} + \frac{v_D^2}{2g} + (z_D - z_A) + h_{LS} + h_{LD}$ $\qquad P_D = P_{cyl}$

$h_A = \frac{30672.3}{56.16} + \frac{(0.1111)^2}{2(32.2)} + (10+5) + 11.5 + 35$

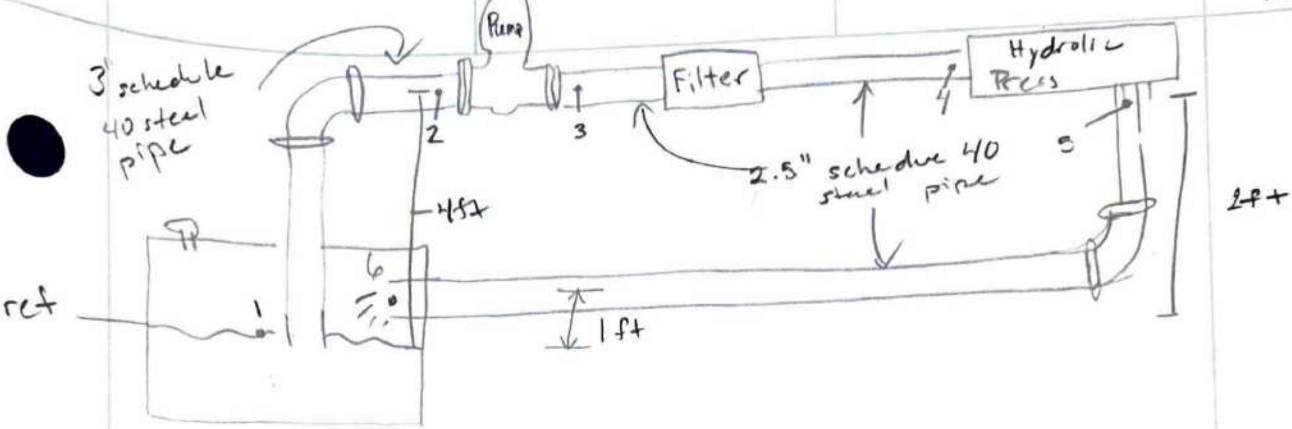
$h_A = 1497.97 \text{ ft}$

$P = h_A \gamma_{oil} \cdot Q$

$P = 1497.97 \text{ ft} \cdot 56.16 \text{ lb/ft}^3 \cdot 0.0152 \text{ ft}^3/\text{s}$

$P = 1274.509 \text{ lb} \cdot \text{ft/s}$

$\boxed{P = 2.317 \text{ hp}}$



1. fluid is oil $(sg = 0.93)$
2. $Q = 175 \text{ gal/min} = 0.39 \text{ ft}^3/\text{s}$
3. Power input to the pump is 28.4 hp
4. Pump efficiency is 80%
5. h_L @ 1-2 = 2.8 lb-ft/lb
6. h_L @ 3-4 = 28.5 lb-ft/lb
7. h_L @ 5-6 = 3.5 lb-ft/lb

$$P_R = \gamma Q h_R$$

4-5

$$\frac{P_4}{\gamma} + \cancel{\frac{V_4^2}{2g}}^{0} + z_4 = \frac{P_5}{2g} + \cancel{\frac{V_5^2}{2g}}^{0} + z_5 + h_R$$

$$h_R = \frac{P_4 - P_5}{\gamma} + z_4 - z_5$$

1-2

$$\cancel{\frac{P_1}{\gamma}}^{0} + \cancel{\frac{V_1^2}{2g}}^{0} + \cancel{z_1}^{0} + \cancel{h_A}^{0} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + \cancel{h_R}^{0} + h_L$$

$$sg = \frac{\gamma_s}{\gamma_w} \qquad Q = V \cdot A$$

$$P_2 = \gamma\left(-\frac{V_2^2}{2g} - z_2 - h_L\right)$$

$$\gamma_s = 0.93(62.4) \text{ lb/ft}^3$$

$$\gamma_s = 58.032 \text{ lb/ft}^3$$

$$= (58.032 \text{ lb/ft}^3)\left(-\frac{(7.6 \text{ ft/s})^2}{2g} - 4 - 2.8\right)$$

$$V_2 = \frac{175 \text{ gal/min}}{0.05132 \text{ ft}^2}\left(\frac{1 \text{ min}}{60 \text{ s}}\right)\left(\frac{0.133681 \text{ ft}^3}{1 \text{ gal}}\right)$$

$$P_2 = 446 \text{ lb/ft}^2$$

$$V_2 = 7.6 \text{ ft/s}$$

2-3

$P = 28.4\ hp = 15620\ lb$
$P = \gamma h_A Q$

$$\frac{P_2}{\gamma} + \frac{v_2^2}{2g} + \cancel{z_2}^0 + h_A = \frac{P_3}{\gamma} + \frac{v_3^2}{2g} + \cancel{z_3}^0$$

$$P_3 = \gamma\left(\frac{P_2}{\gamma} + \frac{v_2^2 - v_3^2}{2g} + h_A\right)$$

$$h_A = \frac{15620\ lb\cdot ft/s}{(58.032\ lb/ft^3)(0.39\ ft^3/s)}$$

$h_A = 690.2\ lb\cdot ft/lb$

$$v_3 = \frac{0.39\ ft^3/s}{0.03326\ ft^2}$$

$v_3 = 11.7\ ft/s$

$$P_3 = (58.032\ lb/ft^3)\left(\frac{446\ lb/ft^2}{58.032\ lb/ft^3} + \frac{(7.6\ ft/s)^2 - (11.7\ ft/s)^2}{2g} + 690.2\ \frac{lb\cdot ft}{lb}\right) ft$$

$P_3 = 39,536.4\ lb/ft^2$

3-4

$$\frac{P_3}{\gamma} + \cancel{\frac{v_3^2}{2g}} + \cancel{z_3}^0 = \frac{P_4}{\gamma} + \cancel{\frac{v_4^2}{2g}} + \cancel{z_4}^0 + h_L$$

same

$$P_4 = \gamma\left(\frac{P_3}{\gamma} - h_L\right)$$

$$= 58.032\ lb/ft^3\left(\frac{39,536.4\ lb/ft^2}{58.032\ lb/ft^3} - 28.5\ \frac{lb\cdot ft}{lb}\right) ft$$

$P_4 = 37,882.49\ lb/ft^2$

5-6

$$\frac{P_5}{\gamma} + \cancel{\frac{v_5^2}{2g}}^0 + z_5 = \cancel{\frac{P_6}{\gamma}}^0 + \cancel{\frac{v_6^2}{2g}}^0 + h_L + z_6$$

$P_5 = (h_L + z_6 - z_5)\gamma$

$P_5 = (3.5\ lb\cdot ft/lb + 1 - 2)\ 58.032\ lb/ft^3$

$P_5 = 145.8\ lb/ft^2$

$$h_R = \frac{P_4 - P_5}{\gamma} + z_4 - z_5$$

$$= \frac{37{,}882.49 \ \cancel{lb}/\cancel{ft^2} - 145.08 \ lb/\cancel{ft^2}}{58.032 \ \cancel{lb}/\cancel{ft^3}} + 2 \ ft$$

$$h_R = 652.3 \ ft$$

$$P_R = (58.032 \ lb/\cancel{ft^3})(0.39 \ \cancel{ft^3}/s)(652.3 \ ft)$$

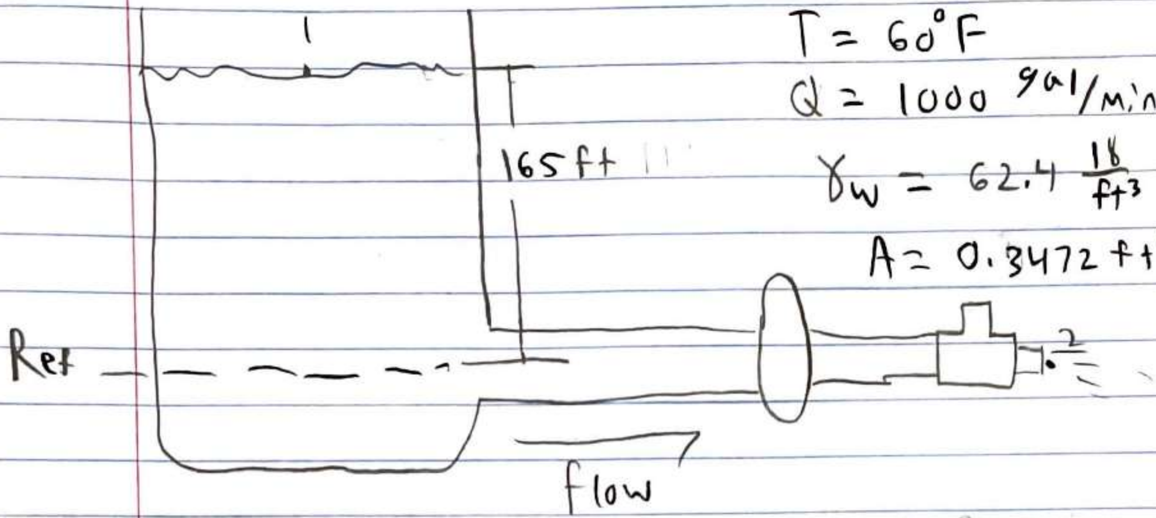
$$P_R = 14152.1 \ lb \cdot ft/s$$

$$P_R = 25.7 \ hP$$

HW 1.3 REFLECTION PARAGRAPH

This week we have learned about the formula for inclined surfaces, and force acting on a submerged curved surface. In one of the problems in the video lecture, we saw that for the decomposed surfaces we have to split them into two parts. Vertical which is equal to weight W, and Horizontal which is equal to the projected area that computes it. Furthermore, we went over on how to obtain the location of the weight for the Vertical surfaces. We just use the centroid of the volume in this case. One of the problems we did had a connection with the force on a curbed surface with fluid below it. We talked about buoyancy and pressure and said that the center of buoyancy is the center of displaced volume. Lastly, the condition for stability of bodies completely submerged in a fluid is that the center of gravity of the body must be below the center of buoyancy.

7.30)



$T = 60°F$

$Q = 1000\ gal/min$

$\gamma_w = 62.4\ \frac{lb}{ft^3}$

$A = 0.3472\ ft^2$

$$\cancel{h_A} + \cancel{\frac{P_1}{\gamma}} + \cancel{\frac{V_1^2}{2g}} + z_1 = \cancel{\frac{P_2}{\gamma}} + \frac{V_2^2}{2g} + \cancel{z_2} + h_R + h_L$$

$1.843E-3\ hp = 1\ \frac{lb\text{-}ft}{s}$

$P_R = h_R \gamma Q$

$$h_R = \frac{P_R}{\gamma Q} = \frac{37\ hp}{\left(62.4\ \frac{lb}{ft^3}\right)\left(1000\ \frac{gal}{min}\right)} = \frac{20076\ \frac{lb\text{-}ft}{s}}{\left(62.4\ \frac{lb}{ft^3}\right)\left(2.23\ \frac{ft^3}{s}\right)} = 144.3\ \frac{lb\ ft}{lb}$$

$$Q = VA \rightarrow V = \frac{Q}{A} = \frac{2.23\ \frac{ft^3}{s}}{0.3472\ ft^2} = 6.42\ \frac{ft}{s}$$

$$h_L = -\frac{V_2^2}{2g} - h_R + z_1 = \frac{6.42^2}{2(32.2)} - 144.3 + 165 = 21.34\ \frac{lb\ ft}{lb}$$

Valve

$$h_L = K\frac{V^2}{2g}$$

$f_T = 0.014$ (from slides)

$K = 8f_T = 8(0.014)$

$K = 0.112$

$$h_L = (0.112)\left(\frac{6.42}{2 \times 32.2}\right)$$

$h_L = 0.011165$

Total : $\boxed{h_L = 21.35\ \frac{lb\ ft}{lb}}$

Fluid Mechanics HW 1.2 Ben Smithson

3.6 Absolute pressure will always be greater than gage pressure. True because the formula is Gage = absolute - atmospheric

$G = ab - atm$

3.7 As long as you stay on the surface of Earth, the atmospheric pressure will be 14.7 psia. True because sea level pressure = 14.7 psia.

$P = 14.7\,psia$

3.8 The pressure in a certain tank is -53.6 Pa (abs). False because pressure cannot be negative in its value.

-53.6

3.9 Group 6

$P_{gage} = -4.65 \text{ psig}$ $P_{atm} = 14.7 \text{ psia}$

$P_{abs} = P_{gage} + P_{atm}$

$P_{abs} = -4.65 \text{ psig} + 14.7 \text{ psia}$

$P_{abs} = 10.05 \text{ psi}$

*TRUE. The absolut pressure is above 0, therefore the gauge pressure obtainable.

$\boxed{3.10}$

$P_{gage} = -175 \text{ kPa (gage)}$

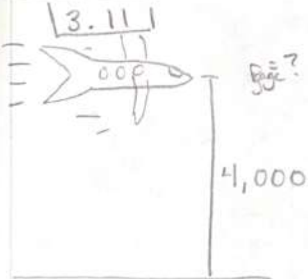
$P_{atm} = 101 \text{ kPa}$

$P_{abs} = -175 \text{ kPa} - 101 \text{ kPa}$

$P_{abs} = -74 \text{ kPa}$

*FALSE! Absolute Pressure cannot be below 0, therefore the gauge pressure cannot be acheived.

$\boxed{3.11}$



$\Delta p = \gamma_{air} h$

$P_{gage} = \Delta P - P_{atm}$

$P_{atm} = 14.7 \text{ psi}$

$4{,}000 \text{ ft} = h \left(\frac{12 \text{ in}}{1 \text{ ft}} \right) = 48{,}000 \text{ in}$

$\gamma_{air} = \frac{0.0765 \text{ lb}}{\cancel{\text{ft}^3}} \left(\frac{\cancel{1 \text{ ft}}}{12 \text{ in}} \right)^3 = 4.43 \times 10^{-5} \text{ lb/in}^3$

$\Delta p = 4.43 \times 10^{-5} \text{ lb/in}^{\cancel{3}\,2} (48{,}000 \cancel{\text{in}})$

$\Delta p = 2.13 \text{ psi}$

$p = 14.7 \text{ psi} - 2.13 \text{ psi}$

$p = 12.57 \text{ psi}$

HW 1.2

01/25/2024
Group 6
Angela Sicaja

3-(13) what is the pressure at the surface of a glass of milk?

$P_{absolute} = P_{gage} + P_{atm}$

$P_{atm} = 0$ gage

$P_{absolute} = P_{atm}$

$P_{gage} = P_{atm} - P_{atm} = 0 - 0$

$\boxed{P_{gage\,(milk)} = 0}$ (gage)

3-(41)

$h = 12.0\,m$

$T = 25°C$

$P = ?$

sg(Ethylene glycol) $= 1.13$

$\rho_{water} = 1000\ kg/m^3$

$P = \rho_{EG}\, g h$

$sg = \dfrac{\rho_{EG}}{\rho_w}$

$\rho_{EG} = sg \cdot \rho_w$

$\rho_{EG} = 1.13 \cdot 1000\ kg/m^3$

$\rho_{EG} = 1130\ kg/m^3$

$P = 1130\ kg/m^3 \cdot 9.81\ m/s^2 \cdot 12m$

$\boxed{P = 133\ 024\,Pa = 133.024\,kPa}$

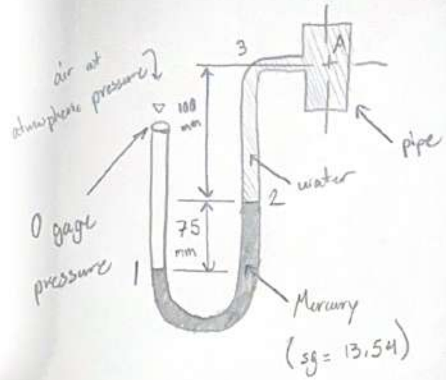
1/24/2024 Pg 1

MET 330

HW 1.2

3.62) Water is in the pipe shown.

Calculate the pressure at point A in kPa (gage)



$100\ mm = 0.1\ m$

$75\ mm = 0.075\ m$

$\Delta p = \gamma h$

$P_1 - \gamma_{mercury}(0.075\ m) - \gamma_{water}(0.175\ m) = P_A$

$P_A = P_1 - \gamma_{mercury}(0.075m) - \gamma_{water}(0.175m)$

$P_1 = P_{atm} = 0\ Pa\ (gage)$

$\gamma_{mercury} = (sg_{mercury})(9.81\ kN/m^3)$

$= (13.54)(9.81\ kN/m^3)$

$= 132.8\ kN/m^3$

$\gamma_{water} = 9.81\ kN/m^3$

$P_A = (0\ Pa_{gage}) - (132.8\ kN/m^3)(0.075m) - (9.81\ kN/m^3)(0.175m)$

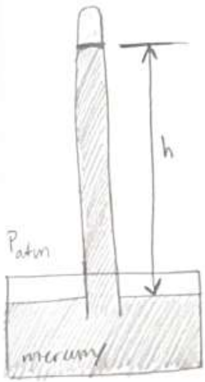
$P_A = (0\ Pa_{gage}) - (9.96\ kN/m^2) - (1.72\ kN/m^2)$

$P_A = -11.68\ kN/m^2$

$\boxed{P_A = -11.68\ kPa_{gage}}$

$kN/m^2 = kPa_{gage}$

3.83) What would be the reading of a barometer in inches of mercury corresponding to an atmospheric pressure of 14.2 psia?



$$0 + \gamma_m h = P_{atm}$$

$$P_{atm} = \gamma_m h$$

$$h = \frac{P_{atm}}{\gamma_m}$$

$$h = \frac{14.2 \ lb/in^2}{\left(\frac{848.7 \ lb}{1728 \ in^3}\right)}$$

$$= \left(14.2 \frac{\cancel{lb}}{\cancel{in^2}}\right)\left(\frac{1728 \ in^{\cancel{3}}}{848.7 \ \cancel{lb}}\right)$$

$$= 14.2\left(\frac{1728 \ in}{848.7}\right)$$

$$\boxed{h = 28.91 \ in}$$

$psia = lb/in^2$

$P_{atm} = 14.2$ psia

$\gamma_m = 848.7 \ lb/ft^3$

$$\left(\frac{848.7 \ lb}{\cancel{ft^3}}\right)\left(\frac{\cancel{ft^3}}{1728 \ in^3}\right)$$

↓

$$\gamma_m = \frac{848.7 \ lb}{1728 \ in^3}$$

3.90)

$P = -12.6\ psi$

From textbook

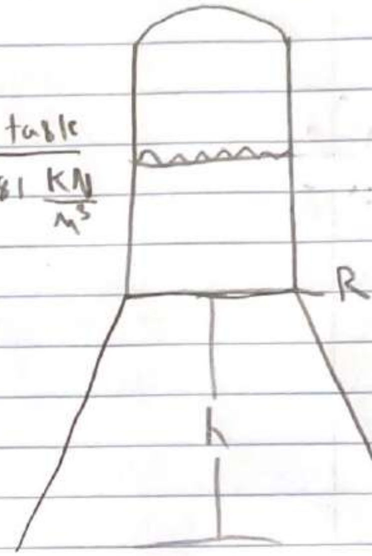
$1.0\ inHg = 0.491\ psi$

$$-12.6\,\cancel{psi}\left(\frac{1\ inHg}{0.491\,\cancel{psi}}\right) = \boxed{-25.67\ inHg}$$

3.94) $P = 160\ KPa$

From table

$\gamma_w = 9.81\ \frac{KN}{M^3}$



$\Delta P = \gamma h$

$P = \gamma_{water} h$

$$h = \frac{P}{\gamma_{water@4°c}}$$

$$h = \frac{160kPa}{9.81\frac{KN}{M^3}} = \frac{160\ \cancel{\frac{KN}{M^2}}}{9.81\cancel{\frac{KN}{M^3}}} \rightarrow \boxed{h = 16.3\ M}$$