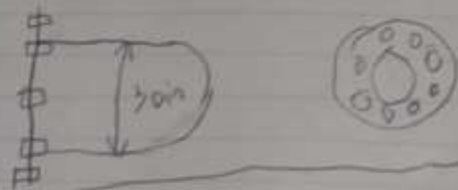
4-2

$P = 23.6\,psig$

4-2 $P = \frac{F}{A} \rightarrow F = P \cdot A$

$A = \frac{\pi (30\,in)^2}{4}$



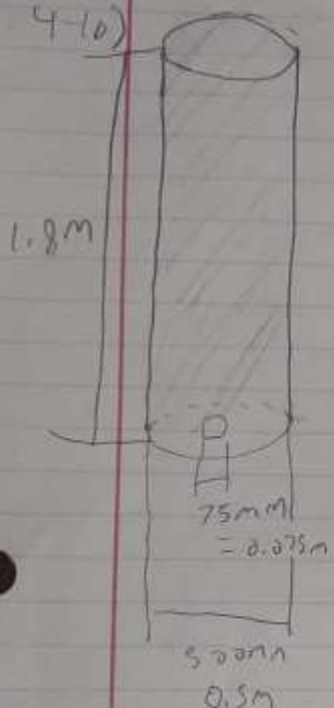
$A = 706.86$

$\rightarrow F = 23.6 \frac{lb}{in^2} \cdot 706.86\,in^2 = 16681.916$

$\frac{F}{8} = F_{bolt} = \frac{16681.916}{8} \rightarrow F_{bolt} = 2085.2416$

4-10

4-10)



$F_{valve} = ?$

$P = \gamma h$

$P = 9810 \frac{N}{m^3} \cdot 1.8m = 17658 \frac{N}{m^2}$

781N

$F = P \cdot A$

$F = 17658 \frac{N}{m^2} \cdot \frac{\pi (0.075m)^2}{4}$

$F = 78.01N$

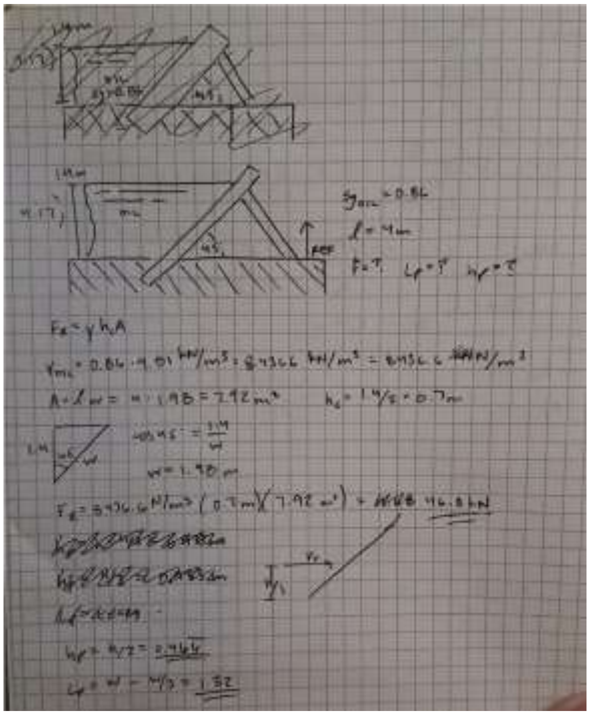
$l_F = 0.065$

$\emptyset = \Sigma M = F_{up} \cdot l_F - F_R \times \frac{1}{2}$

$\emptyset = F_{up} \cdot 0.065 - 780 \cdot \frac{1}{2} \cdot 78.01N$

$F_{up} = 45.86N$

4-17



$sg_{oil} = 0.86$
$\ell = 4m$
$F_R = ?$ $L_p = ?$ $h_p = ?$
$F_R = \gamma h_c A$
$\gamma_{oil} = 0.86 \cdot 9.81\ kN/m^3 = 8.4366\ kN/m^3 = 8436.6\ N/m^3$
$A = \ell w = 4 \cdot 1.98 = 7.92\ m^2$
$h_c = 1.4/2 = 0.7m$
$w = 1.98\ m$
$F_R = 8436.6\ N/m^3\ (0.7m)(7.92\ m^2) = 46.8\ kN$
$h_p = 1.4/3 = 0.466$
$L_p = w - w/3 = 1.32$

4-28

4-29) $D = 3.33\,ft$

$$A = \frac{\pi D^2}{8} = 4.35\,ft^2$$

$$Sw_{H_2O} = 62.4\,\frac{lbf}{ft^3}$$

*appendix

$$F_R = \gamma_{oil}\, h_c\, A$$

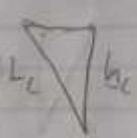
$$L_p = L_c + \frac{I_c}{L_c A}$$

$1.332\,ft$

$x = 1.192\,ft$

$\underbrace{0.212\,(D)}_{L_c = 2.025\,ft}$ $\quad \underbrace{(6.86\times10^{-3})(D^4)}_{I_c}$

$I_c = 0.844\,ft^4$



2.020

$$Sg = \frac{S_{oil}}{S_{H_2O}}$$

$$Sg \cdot \gamma_{H_2O} = \gamma_{oil}$$

$$1.10 \cdot 62.4\,\frac{lb}{ft^3} = \gamma_{oil}$$

$$\gamma_{oil} = 68.64\,\frac{lb}{ft^3}$$

$$h_c = 2.025\,\cos(30°)$$

$$h_c = 1.754\,ft$$

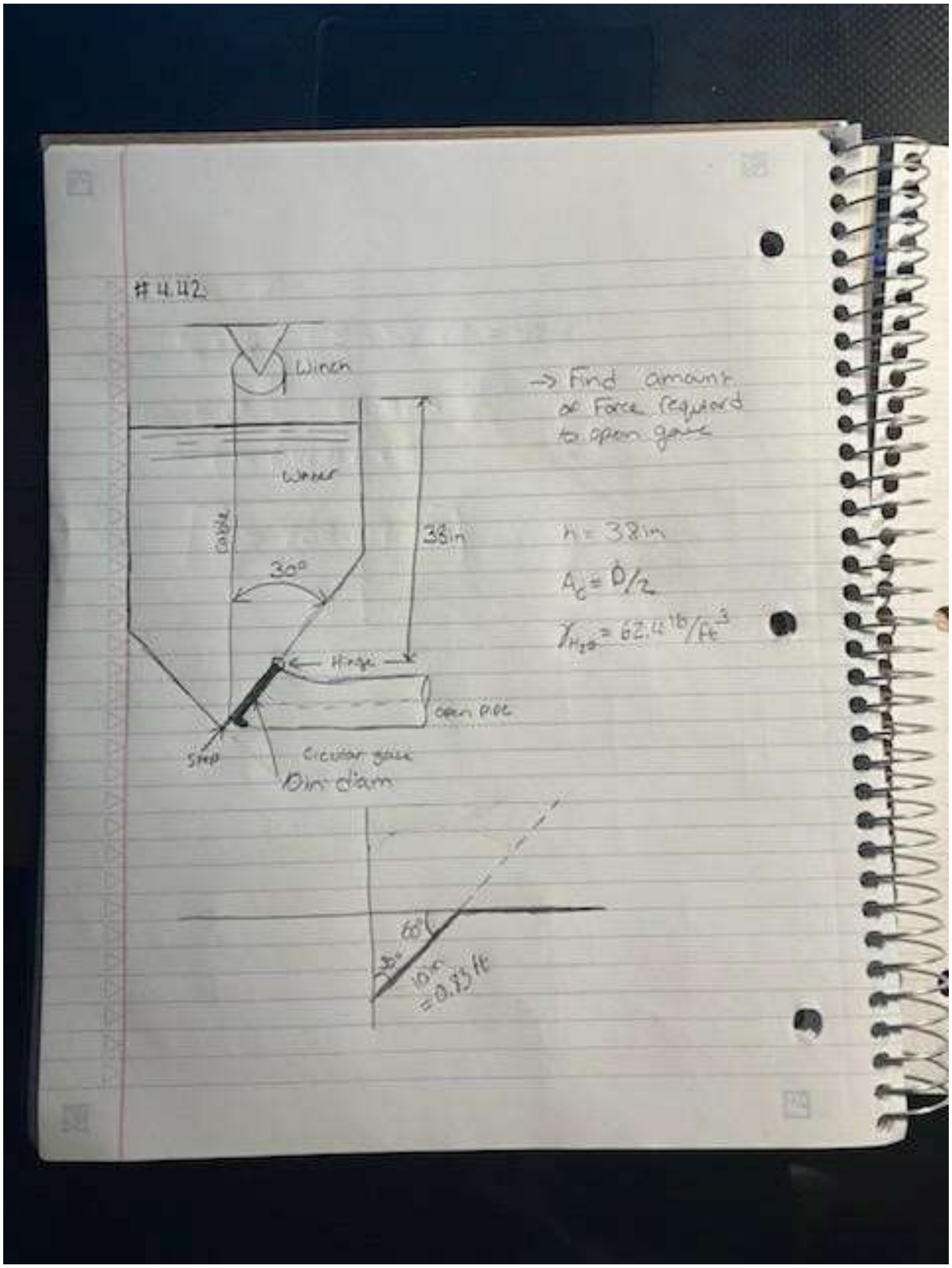
$$L_p = 2.025\,ft + \frac{0.844\,ft^4}{2.025\,ft \times 4.35\,ft^2}$$

$$L_p = 2.12\,ft$$

$$F_R = 64.64\,\frac{lb}{ft^3} \cdot 1.759\,ft \cdot 4.35\,ft^2$$

$$F_R = \underline{523.72\,lb}$$

4-42



4.42
Winch
Water
Cable
30°
38in
Hinge
open pipe
Stop
Circular gate
10in diam
→ Find amount of Force required to open gate
h = 38 in
$A_c = D/2$
$\gamma_{H_2O} = 62.4\ lb/ft^3$
60°
30°
10 in
= 0.83 ft

$h_c = A \sin 60°$

$h_c = \frac{0.83}{2} \sin 60°$

$h_c = 0.36$ ft

$F_R = F_g (h + h_c) A$

$= 110 \times \underset{ft/s^2}{32.2} (3.167 + 0.361 \text{ ft}) \times \frac{\pi}{4}(0.83)^2$

$F_R = 614.47$ N

y_p (centre of P) $= y_c + \frac{I_c}{y_c A}$

$y_c = d/2$

$y_p = y_c + I/y_c A = \frac{d}{2} + \frac{\pi d^4}{64 \times \frac{d}{2} \times \frac{\pi d^4}{4}}$

$y_p = d/2 + d/8 = \frac{5d}{8}$

$$\Sigma M_A = \varnothing$$

$$-F_R \cdot y_p + F \sin 30° \times d = \varnothing$$

$$F \times \frac{\cancel{d}}{2} = 614.47 \times \frac{5\cancel{d}}{\cancel{8}_4}$$

$$F = 614.47 \times \frac{5}{4}$$

$$\boxed{F = 768.09 \text{ N}}$$

60 in Long

$Sg = 0.79$

$Sg = \frac{\gamma_{oil}}{\gamma_{water}}$

$0.79 \cdot 9810 \frac{N}{m^3} = 7749.9 \frac{N}{m^3}$

$7749.9 \frac{N}{m^3} \cdot \frac{1 \, lbf}{4.448 \, N} \cdot \frac{1 \, m^3}{1 \, ft^3}$

$85243.9669 \frac{lb}{in^3}$

$F_v = \gamma \left((36in \cdot 78in) \cdot 60in \cdot 1/2 \right) - \left(\frac{\pi \cdot (36in)^2}{8} \cdot 60 \right)$

$F_v = 386245698.316$

$F_h = \gamma \cdot h_c \cdot A$

$h_c = \bar{y} = \frac{D}{2} + 48in = \frac{36in}{2} + 48in \Rightarrow 66in$

so $A = 36in$

$= 85243.9661 \frac{lb}{in^3} \cdot 66in \cdot 36in \cdot 60in$

$F_h = 2025396653.416$

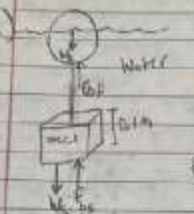
$F_r = \sqrt{(2025396653.416)^2 + (386245698.316)^2} = 436128485.116$

$\theta = \tan^{-1} \frac{F_v}{F_h} = \tan^{-1}\left(\frac{3862456 98.316}{2025396653.416} \right) = 62.32836512°$

$\boxed{436128485.116 \angle 62.33°}$

5-8

5.8.)



$\gamma_{foam} = 470 \frac{N}{m^3}$ $\quad$ $\gamma_{H_2O} = 9810 \frac{N}{m^3}$

$\gamma_{steel} = 78500 \frac{N}{m^3}$

$V_{foam} = ?$ $\quad$ $F_b = \gamma_f V_B$

$F_{steel,B} = \gamma_{fluid} V_{steel} = 9810 \frac{N}{m^3} \cdot 0.001 m^3 = 9.81 N$

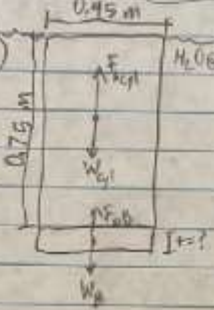
$F_{net_y} = F_{bs} + F_{bf} - W_s - W_F = 0$ $\quad$ $9.81 + \gamma_f V_F - 80N - \gamma_F V_F = 0$

$80N - 9.81N = \gamma_F V_F - \gamma_f V_F \Rightarrow 70.2N = V_F(\gamma_f - \gamma_F)$

$\frac{70.2N}{\gamma_f - \gamma_F} = V_F = \frac{70.2N}{9810\frac{N}{m^3} - 470\frac{N}{m^3}} \Rightarrow \boxed{V_F = 0.00752\ m^3}$

5-24

5.24.)



H_2O @ 95°C $\gamma_{cylinder} = 6.456 \frac{kN}{m^3}$ $\gamma_{H_2O @ 95°C} = 9.44 \frac{kN}{m^3}$ ← Table A.1

$\gamma_{brass} = 840 \frac{kN}{m^3}$ $V_{cyl} = 0.119 \, m^3$

$F_{net_y} = F_{b_{cyl}} + F_{bB} - W_{cyl} - W_B = 0$

t=?

$F_{b_{cyl}} = \gamma_c V_c = 9.44 \frac{kN}{m^3} \cdot \underbrace{\left(\frac{\pi (0.45^2)}{4} 0.75 m\right)}_{0.119 m^3} \Rightarrow F_{b_{cyl}} = 1.13 \, kN$

$W_{cyl} = \gamma_{cyl} \cdot V_{cyl} = 6.456 \frac{kN}{m^3} \cdot 0.119 m^3 = 0.768 \, kN$

$1.13 \, kN - 0.768 \, kN + \gamma_{H_2O} \cdot V_B - \gamma_B \cdot V_B = 0$

$V_B(-\gamma_{H_2O} + \gamma_B) = 0.362 \, kN$

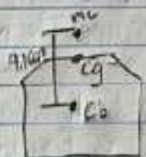
$V_B = \frac{0.362 \, kN}{84 \frac{kN}{m^3} - 9.44 \frac{kN}{m^3}} \Rightarrow V_B = 0.0049 \, m^3$

$V_B = \frac{\pi (D^2)}{4} \cdot t \Rightarrow \frac{V_B}{\frac{\pi (D^2)}{4}} = t \quad \frac{0.0049 m^3}{\frac{\pi (0.45 m^2)}{4}} = \boxed{t = 0.031 \, m}$

5.41)

$MB = \frac{I}{V_D} = 4.16667 ft$

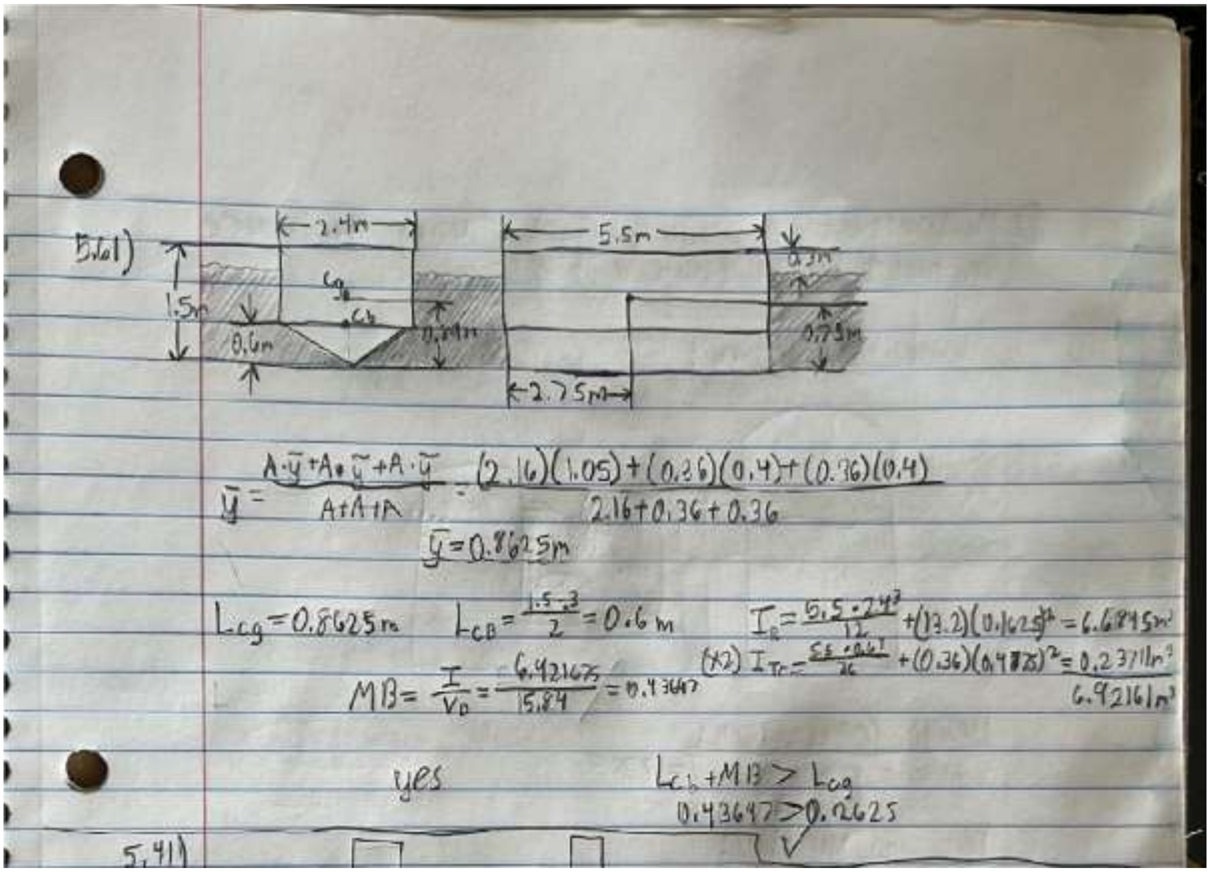
$L_{CB} = \frac{8 ft}{2} = 4 ft$



$L_{mc} = 4.16667 + 4 = 8.1667$

$L_{cg} = 8 ft$

5-41 5-61



In the static fluids example problems, we learned that when dealing with hinges and latches, you have to apply the sum of the moments. This can be seen in the second example problem. Additionally, we learned how to analyze the pressure of inclined walls. When dealing with those one must find the centroid, inertia, and the distances from the surface to the center. When dealing with composite shapes, you have to divide the shape into simpler ones and find the average. Some shapes might be curved as seen in the second part of the practice problems. To find the pressures for those, you have to put an imaginary column above the curved shape. Subtracting the imaginary part from the curved surface allows you to find the net volume of the fluid.

When dealing with objects that float, its weight is ALWAYS equal to the buoyancy force. This can be easily seen in Example 1 of the Buoyancy and Stability Problems. If the weight is larger, then the object will just sink to the bottom. On the other hand, if the weight is less than buoyancy force and it is submerged in the liquid, the object will move up to the surface. Additionally, we also learned how to diagram a buoyancy problem. The metacenter (mc) must be above the center of gravity at a distance “MB”. Additionally, the center of buoyancy (cb) is located at the centroid of the submerged volume. This can be seen in the second example of the problems.