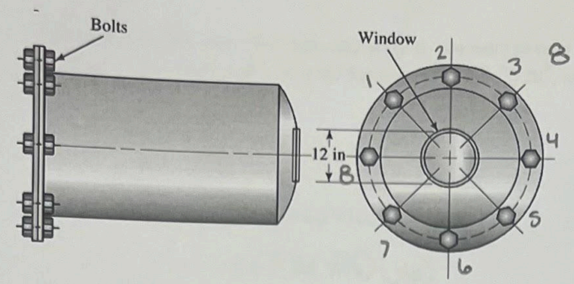


8 bolts

Tank for Problems 4.1 and 4.2.

4.2 The flat left end of the tank shown in **Fig. P4.1** is secured with a bolted flange. If the inside diameter of the tank is 30 in and the internal pressure is raised to **+23.6 psig**, calculate the total force that must be resisted by the bolts in the flange.

$$A = \frac{\pi d^2}{4} = \frac{\pi (30 in)^2}{4} = 708.86\ in^2$$

D = 30 in

$P \cdot A = F$

$P_{internal} = 23.6$ psig

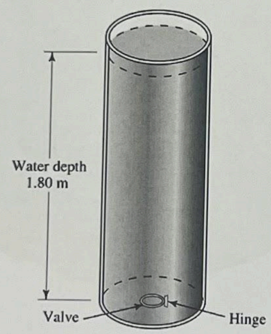
$(708.86\ in^2)(23.6\ \#/in) = F_{total}$

$F_{total} = \boxed{16,681.9\ lbs}$

2085.237 lbs per bolt

4.10 A simple shower for remote locations is designed with a cylindrical tank 500 mm in diameter and 1.800 m high as shown in **Fig. P4.10**. The water flows through a flapper valve in the bottom through a 75-mm-diameter opening. The flapper must be pushed upward to open the valve. How much force is required to open the valve?

Figure P4.10



(a) General view of shower tank and valve

Force to open > F_F

$\gamma h = P$

$= (1.8)(9.81\ kN)$

$= 17.658\ \frac{kN}{m^2}$

$F = PA$

$= (17.658\ \frac{kN}{m^2})(0.00442\ m^2)$

$= .078\ kN \cdot \frac{1000 N}{1 kN}$

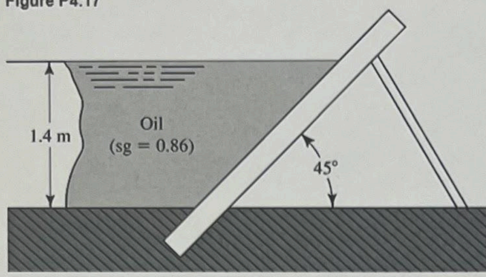
$\boxed{78.01\ N}$

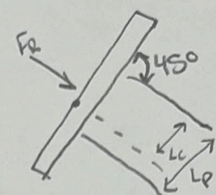
Area of flange $= (75mm)\left(\frac{1 in}{1000 mm}\right) = .075$ in

$$A = \frac{\pi d^2}{4} = \frac{\pi (.075m)^2}{4} = \boxed{.00442\ m^2}$$

4.17 If the wall in **Fig. P4.17** is 4 m long, calculate the total force on the wall due to the oil pressure. Also determine the location of the center of pressure and show the resultant force on the wall.

Figure P4.17





$L_w = 4m$

$h = 1.4m$

$Sg_{oil} = .86$

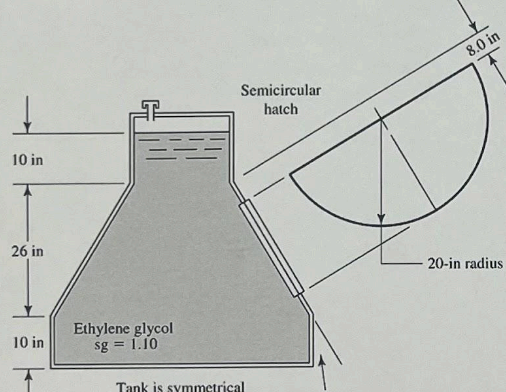
$L_c = \frac{h_c}{\sin 45} = \frac{1.4}{\sin 45} = 1.98m$

$F_R = \gamma h_c A = (.86 \times 1000)(9.81)(\frac{1.4}{2})(1.98)(4)$

$\boxed{F_R = 46.77\ KN}$

$L_p = \frac{2l}{3} = \frac{2(1.98)}{3} = \boxed{1.32m}$

Figure P4.28



Problems 4.28 and 4.46

$Sg_{eg} = 1.10$

$\bar{y} = \frac{4r}{3\pi} = \frac{4(20)}{3\pi} = 8.49\ in$

$L_c = 8 + 8.49 + \frac{10}{\cos 30}$

$L_c = 28.04\ in$

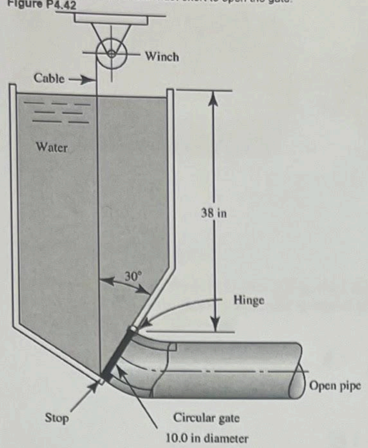
$h_c = L_c \cos 30 = 24.283\ in$

$h_p = h_c + \frac{L_c \sin^2\theta}{h_c A} = 24.283m +$

$= 24.383 + \frac{\pi/64\,(40)^4 \sin^2 60}{\pi/4\,(40)^2\,(24.283)} = \boxed{27.37\ m}$

4.42 **Figure P4.42** shows a tank of water with a circular pipe connected to its bottom. A circular gate seals the pipe opening to prohibit flow. To drain the tank, a winch is used to pull the gate open. Compute the amount of force that the winch cable must exert to open the gate.

Figure P4.42



$A = \frac{\pi d^2}{4}$ $\quad I_c = \frac{\pi d^4}{64}$

$= \frac{\pi (10)^2}{4}$ $\quad = \frac{\pi (10)^4}{64}$

$= 78.54 \text{ in}^2$ $\quad = 490.87 \text{ in}^4$

$(78.54 \text{ in}^2)\left(\frac{1 \text{ ft}}{12 \text{ in}}\right)^2 = .545 \text{ ft}^2$

$\cos 30 = \frac{A}{5}$

$4.33 \text{ in} + 38 \text{ in} = h_c = 42.33$

$\cos 30 = \frac{A}{6} = 5.196 + 38 = 43.196 = h_p$

$F_R = \gamma h_c A$

$= (62.4 \frac{\text{lb}}{\text{ft}^3})(43.33 \text{ in})\left(\frac{1 \text{ ft}}{12 \text{ in}}\right)(.545 \text{ ft}^2)$

$= 122.797 \text{ lbs}$

$\Sigma M_A = F_R(6'') - F_w(10'')\sin 30 = 0$

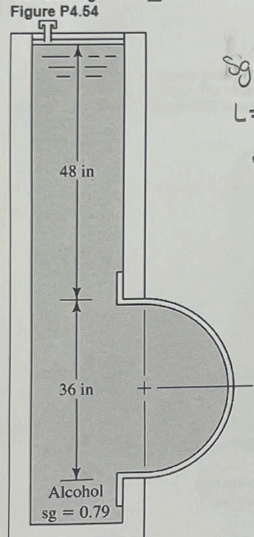
$F_w(10'')\sin 30 = F_R(6)$

$F_w = \frac{122.797\,(6 \text{ in})}{10'' \sin 30°}$

$\boxed{F_{winch} = 147.356 \text{ lbs}}$

4.54 Use **Fig. P4.54**. The surface is 60 in long.

Figure P4.54



$sg_{Alch} = .79$

$L = 60 \text{ in}$

$F_H = \gamma A h$

$= ((.79)(62.44)) \times (3 \times 5) \times (48 + \frac{36}{2})$

$= 4069.527 \text{ lb}$

$F_V = (.79 \times 62.44) \times [(7.5 \times 1.5 \times 5) - \frac{\pi}{4} \times 1.5^2 \times 5)]$

$= 2338.36 \text{ lb}$

$F_R = \sqrt{F_H^2 - F_V^2}$

$\sqrt{(4069.3)^2 - (2338.36)^2}$

$= 3330.62 \text{ lb}$

$\tan^{-1} = \frac{2338.38}{4069.527} = 29.8°$

5.8 A steel cube 100 mm on a side weighs 80 N. We want to hold the cube in equilibrium under water by attaching a light foam buoy to it. If the foam weighs $470\ \mathrm{N/m^3}$, what is the minimum required volume of the buoy?

$V_{cube} = (100mm)\left(\frac{1m}{1000mm}\right) = (.1m)^3 = .1m^3$

$F_{B\,cube} = (.1m)^3 (9.81\ kN/m^3)$

$= 9.81\ kN$

$= 981\ N$

$F_{D\,foam} = W_{foam}$

$F_c = \gamma_{H_2O} V_{foam}$

$= (9.81\ \frac{kN}{m^3})(V_d)$

$0 = W_{foam} + W_{steel} - F_{B\,steel} - F_{B\,foam}$

$= (470\ N/m^3)(V) + 80N - 981N - 981\ \frac{kN}{m^3}$

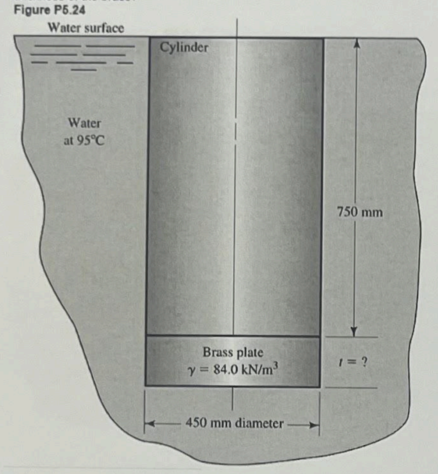
$901N = 470\ \frac{N}{m^3}(V) - 9810\ N/m^3\ (V)$

$901N = -9340\ N/m^3\ (V)$

$\boxed{V = .0965\ m^3}$

5.24 A brass weight is to be attached to the bottom of the cylinder described in Problems 5.22 and 5.23, so that the cylinder will be completely submerged and neutrally buoyant in water at 95 °C. The brass is to be a cylinder with the same diameter as the original cylinder as shown in **Fig. P5.24**. What is the required thickness of the brass?

Figure P5.24



$\gamma_b = 84.0\ kN/m^3$

$T_N = 95°C \quad D = 450mm \quad L = 750mm$

$\Sigma F = 0 \quad F_D + F_c - W_c - W_b = 0$

$W_c = \gamma V = (6.45)(\pi/4\,(.45)^2\,(.75)) = .77kN$

$W_b = \gamma_b V_b = (84)(\pi/4)(.45)^2 t$

$W_b = 13.36t\ kN$

$F_c = \gamma_{H_2O} V = (9.44)(\pi/4)(.45)^2(.75) =$

$= 1.125\ kN$

$F_b = \gamma_{H_2O} V = 9.44(\pi/4)(.45)^2 t = 1.5t\ kN$

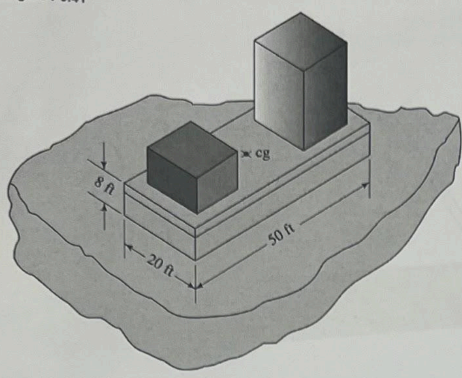
$1.5t + 1.125 - .77 - 13.36t = 0$

$11.86t = .355 \Rightarrow t = .0299m$

$\boxed{= 30\ mm}$

5.41 The large platform shown in **Fig. P5.41** carries equipment and supplies to offshore installations. The total weight of the system is 450 000 lb, and its center of gravity is even with the top of the platform, 8 ft from the bottom. Will the platform be stable in seawater in the position shown?

Figure P5.41



$$V_{H2O} = \frac{\text{Weight}_{H2O}}{\text{density}}$$

$P_L = 450000$ lbs

Density $= 65$ lbs ft^3

$$V_{H2O} = \frac{450000}{64} = 7031.25$$

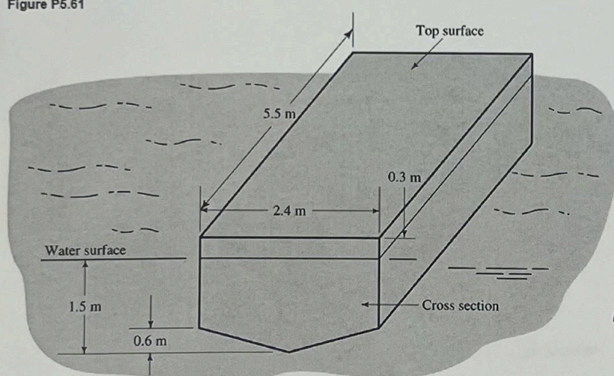
$A = L \times W = 50 \times 20 = 1000$ sq ft

$$\frac{7031.25}{1000} = \boxed{7.03 \text{ ft}}$$

7.03 bellow water

5.61 A boat is shown in **Fig. P5.61** Its geometry at the water line is the same as the top surface. The hull is solid. Is the boat stable?

Figure P5.61



$H = 1.8$ m
$W = 2.4$m
$L = 5.5$m
$D = 1.5$m

$A = A_{rec} + A_{tri}$

$A = (1.2 \times 2.4) + (\frac{1}{2} \times 2.4 \times .6)$

$A_{total} = 3.6 m^2$

$A_{under} = (.9 \times 2.4) + (\frac{1}{2} \times 2.4 \times .6)$

$A_{under} = 2.88 m^2$

$$Y_{cb} = \frac{A_1 Y_1 + A_2 Y_2}{A_{under}} = \frac{(.5 \times 2.4 \times .6)(1.2/3)(2.16)(1.05)}{2.88}$$

$y_{cb} = .888$m

$$Y_{cg} = \frac{A_1 Y_1 + A_2 Y_2}{A_{total}}$$

$$Y_{cg} = \frac{(.72) * \frac{2b}{3} (2.88)(.36)}{3.6}$$

$Y_{cg} = 1.64$m

$V_d = A_{under} B$

$V_d = (2.88)(5.5)$

$V_d = 15.84 m^3$

$$m_B = \frac{1}{V_d} = MB = .4m$$

$I = I_R + I_T$

$$I = \frac{BH^3}{12} = 6.336 m^4$$

$y_{mc} = y_{CB} + MB$

$= .888 + .4$

$\boxed{= 1.288 > y_{mc}}$ Yes it will float