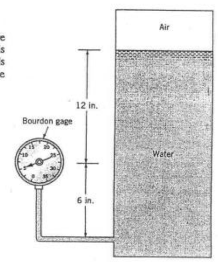
Homework Assignment #3 – Solutions

2.27

2.27 Bourdon gages (see Video V2.4 and Fig. 2.13) are commonly used to measure pressure. When such a gage is attached to the closed water tank of Fig. P2.27 the gage reads 5 psi. What is the absolute air pressure in the tank? Assume standard atmospheric pressure of 14.7 psi.



■ FIGURE P2.27

$$p = \gamma h + p_o$$

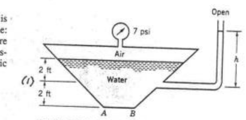
$$p_{gage} - \left(\frac{12}{12}\ ft\right)\gamma_{H_2O} = p_{air}$$

$$p_{air} = \left(5\ \frac{lb}{in.^2} + 14.7\ \frac{lb}{in.^2}\right) - \frac{(1\ ft)\left(62.4\ \frac{lb}{ft^3}\right)}{144\ \frac{in.^2}{ft^2}}$$

$$p_{air} = \underline{\underline{19.3\ psia}}$$

2.34

2.34 The closed tank of Fig. P2.34 is filled with water and is 5 ft long. The pressure gage on the tank reads 7 psi. Determine: (a) the height, h, in the open water column, (b) the gage pressure acting on the bottom tank surface AB, and (c) the absolute pressure of the air in the top of the tank if the local atmospheric pressure is 14.7 psia.



■ FIGURE P2.34

$$p = \gamma h + p_o$$

(a) $p_1 = \gamma_{H_2O}\,(2\,ft) + p_{air}$

Also $p_1 = \gamma_{H_2O}\, h$ so that

$$\left(62.4\ \frac{lb}{ft^3}\right) h = \left(62.4\ \frac{lb}{ft^3}\right)(2\,ft) + \left(7\ \frac{lb}{in.^2}\right)\left(\frac{144\ in.^2}{ft^2}\right)$$

or

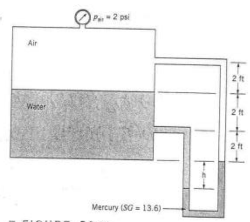
$$h = \underline{\underline{18.2\ ft}}$$

(b) $p_{AB} = \left[\left(62.4\ \frac{lb}{ft^3}\right)(4\,ft) + \left(7\ \frac{lb}{in.^2}\right)\left(\frac{144\ in.^2}{ft^2}\right)\right]\left(\frac{1\ ft^2}{144\ in.^2}\right) = \underline{\underline{8.73\ psi}}$

(c) $p_{air} = 7\ psi + 14.7\ psia = \underline{\underline{21.7\ psia}}$

2.36

2.36 A U-tube mercury manometer is connected to a closed pressurized tank as illustrated in Fig. P2.36. If the air pressure is 2 psi, determine the differential reading, h. The specific weight of the air is negligible.



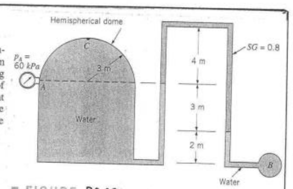
■ FIGURE P2.36

$$p_{air} + \gamma_{Hg} h - \gamma_{H_2O}(h + 4 ft) = p_{air}$$

$$h = \frac{\gamma_{H_2O}(4 ft)}{\gamma_{Hg} - \gamma_{H_2O}} = \frac{(62.4 \frac{lb}{ft^3})(4 ft)}{(13.6)(62.4 \frac{lb}{ft^3}) - 62.4 \frac{lb}{ft^3}} = \underline{\underline{0.317 ft}}$$

2.39

2.39 A closed cylindrical tank filled with water has a hemispherical dome and is connected to an inverted piping system as shown in Fig. P2.39. The liquid in the top part of the piping system has a specific gravity of 0.8, and the remaining parts of the system are filled with water. If the pressure gage reading at A is 60 kPa, determine: **(a)** the pressure in pipe B, and **(b)** the pressure head, in millimeters of mercury, at the top of the dome (point C).



■ FIGURE P2.39

(a) $$p_A + (SG)(\gamma_{H_2O})(3 m) + \gamma_{H_2O}(2 m) = p_B$$

$$p_B = 60 kPa + (0.8)(9.81 \times 10^3 \frac{N}{m^3})(3 m) + (9.80 \times 10^3 \frac{N}{m^3})(2 m)$$

$$= \underline{\underline{103 kPa}}$$

(b) $$p_C = p_A - \gamma_{H_2O}(3 m)$$

$$= 60 kPa - (9.80 \times 10^3 \frac{N}{m^3})(3 m)$$

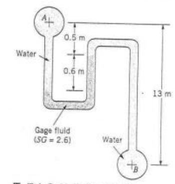
$$= 30.6 \times 10^3 \frac{N}{m^2}$$

$$h = \frac{p_C}{\gamma_{Hg}} = \frac{30.6 \times 10^3 \frac{N}{m^2}}{133 \times 10^3 \frac{N}{m^3}} = 0.230 m$$

$$= 0.230 m \left(\frac{10^3 mm}{m}\right) = \underline{\underline{230 mm}}$$

2.40

2.40 Two pipes are connected by a manometer as shown in Fig. P2.40. Determine the pressure difference, $p_A - p_B$, between the pipes.



■ FIGURE P2.40

$$p_A + \gamma_{H_2O}(0.5m + 0.6m) - \gamma_{gf}(0.6m) + \gamma_{H_2O}(1.3m - 0.5m) = p_B$$

Thus,

$$p_A - p_B = \gamma_{gf}(0.6m) - \gamma_{H_2O}(0.5m + 0.6m + 1.3m - 0.5m)$$

$$= (2.6)(9.81 \tfrac{kN}{m^3})(0.6m) - (9.80 \tfrac{kN}{m^3})(1.9m)$$

$$= \underline{\underline{-3.32\ kPa}}$$