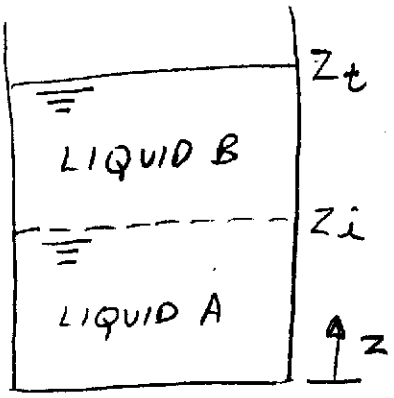
3.6

GIVEN: A TANK WITH TWO IMMISIBLE LIQUIDS

$\gamma_A > \gamma_B$



FIND: CORRECT DISTRIBUTION OF GAGE PRESSURE ALONG A VERTICAL LINE THROUGH THE LIQUIDS

SOLUTION:

1. THE GAGE PRESSURE AT THE SURFACE IS ZERO.

2. LIQUID B: $p_B = C_1 - \gamma_B z$ ← PIEZOMETRIC HEAD EQN.

LINEAR VARIATION IN GAGE PRESSURE WITH SLOPE, $\frac{dp}{dz} = -\gamma_B$.

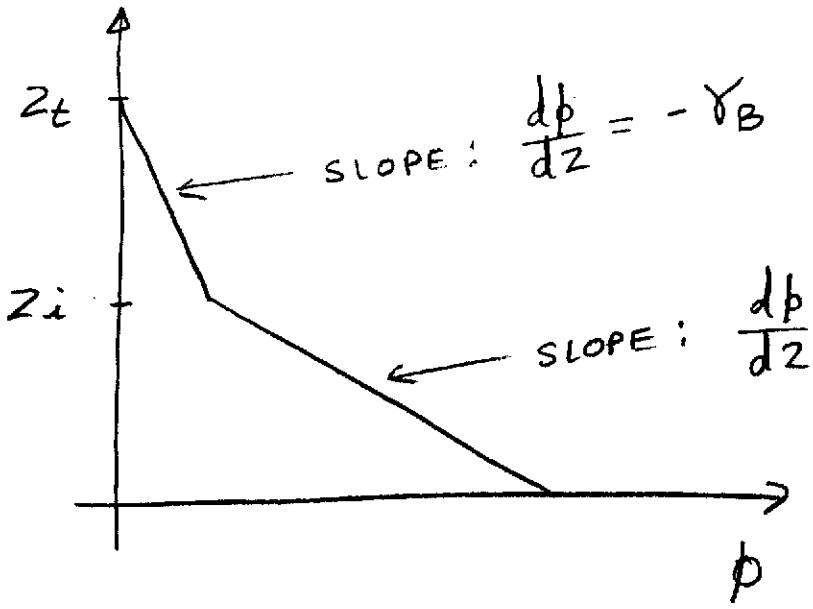
3. AT INTERFACE, $z = z_i$, THE PRESSURES MATCH.

$$p_A = p_B$$

4. LIQUID A: $p_A = C_2 - \gamma_A z$

LINEAR VARIATION IN GAGE PRESSURE WITH SLOPE, $\frac{dp}{dz} = -\gamma_A$.

3.6 CONTINUED



$\gamma_A > \gamma_B$

THIS IS CHOICE (b) IN TEXT.

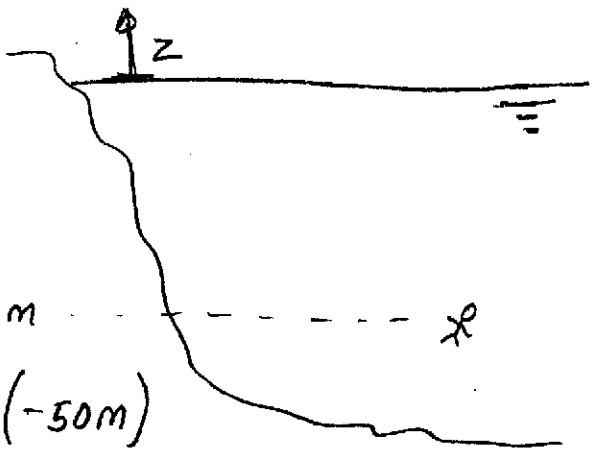
3.10 GIVEN: DIVER AT DEPTH OF 50 m. $T = 20^\circ C$

FIND: (a) GAGE PRESSURE AT THAT DEPTH

(b) RATIO OF ABSOLUTE PRESSURE AT THAT DEPTH TO STANDARD ABSOLUTE ATMOSPHERIC PRESSURE.

SOLUTION:

(a) $p + \gamma z = C_1$



AT SURFACE: $p = 0$ GAGE

$z = 0$

$\Rightarrow C_1 = 0$

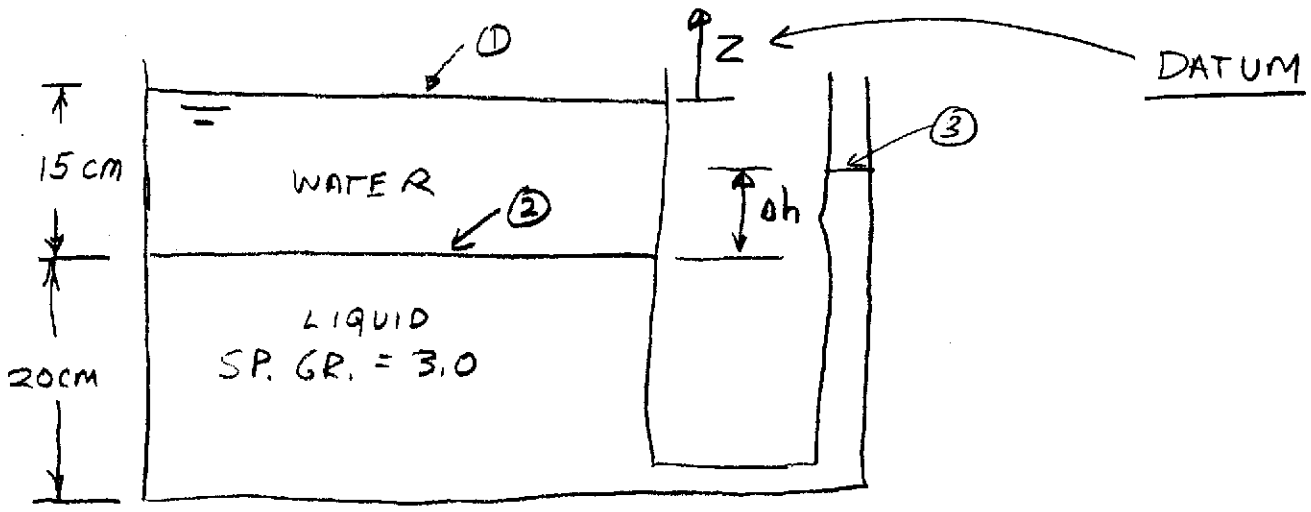
$p = -\gamma z = -\left(9790 \frac{N}{m^3}\right)(-50m)$

$p = 490\ kPa$ GAGE

(b) $\text{RATIO} = \dfrac{490\ kPa + 101\ kPa}{101\ kPa}$

$\text{RATIO} = 5.85$

3.15 GIVEN: TANK AS SHOWN.



FIND: Δh

SOLUTION: WRITE PIEZOMETRIC HEAD EQUATION FROM ① TO ② AND FROM ② TO ③. SET DATUM AS SHOWN ON FIGURE.

$$\frac{p_1}{\gamma_w}^{0} + z_1^{0} = \frac{p_2}{\gamma_w} + z_2 \rightarrow p_2 = -\gamma_w z_2$$

$$\frac{p_2}{\gamma_L} + z_2 = \frac{p_3}{\gamma_L}^{0} + z_3 \rightarrow p_2 = \gamma_L z_3 - \gamma_L z_2$$

COMBINE TO ELIMINATE p_2. SOLVE FOR z_3.

$$0 = -\gamma_w z_2 - \gamma_L z_3 + \gamma_L z_2$$

$$z_3 = z_2 - \frac{\gamma_w}{\gamma_L} z_2 = \left(1 - \frac{\gamma_w}{\gamma_L}\right) z_2$$

DEFINITION OF SPECIFIC GRAVITY: $S_L = \frac{\gamma_L}{\gamma_w}$

$$z_3 = \left(1 - \frac{1}{S_L}\right) z_2 = \left(1 - \frac{1}{3}\right) z_2 = \frac{2}{3} z_2$$

$$z_3 = \frac{2}{3}(-15) = -10\,cm \qquad \Delta h = z_3 - z_2$$

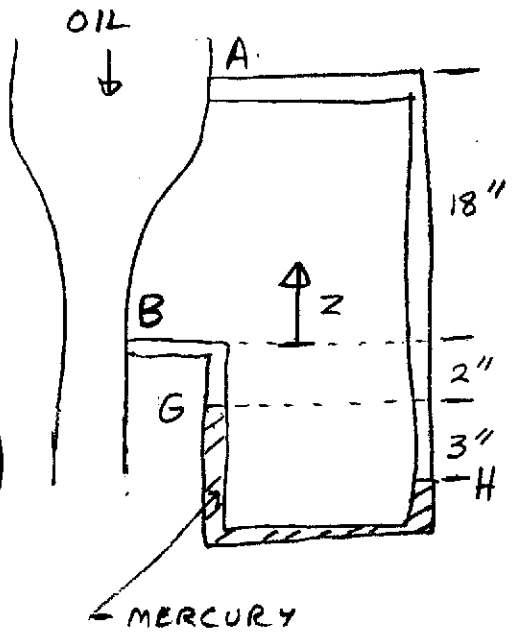
$$\Delta h = -10 + 15 = 5\ cm$$

$$\boxed{\Delta h = 5\ cm}$$

3.42

GIVEN: MERCURY MANOMETER CONNECTED TO OIL PIPE.

$S_{OIL} = 0.95$



FIND: (a) $p_A - p_B$

(b) $\left(\frac{p_A}{\gamma_{OIL}} + Z_A\right) - \left(\frac{p_B}{\gamma_{OIL}} + Z_B\right)$

SOLUTION:

APPLY PIEZOMETRIC HEAD EQN. FROM B TO G.

① $p_B + \gamma_{OIL} Z_B = p_G + \gamma_{OIL} Z_G$ $\quad Z_G = -2"$

$Z_B = 0$

APPLY P. H. EQN. FROM G TO H.

② $p_G + \gamma_{Hg} Z_G = p_H + \gamma_{Hg} Z_H$ $\quad Z_G = -2"$, $Z_H = -5"$

APPLY P. H. EQN. FROM H TO A

③ $p_H + \gamma_{OIL} Z_H = p_A + \gamma_{OIL} Z_A$ $\quad Z_H = -5"$, $Z_A = 18"$

NEED TO SOLVE FOR $p_A - p_B$

ADD EQNS. ① & ③

$$p_B + p_H + \gamma_{OIL} Z_H = p_A + p_G + \gamma_{OIL}(Z_G + Z_A)$$

ADD EQN. ② TO THIS

$$p_B + p_H + \gamma_{OIL} Z_H + p_G + \gamma_{Hg} Z_G = p_A + p_G + \gamma_{OIL} Z_G + p_H + \gamma_{Hg} Z_H + \gamma_{OIL} Z_A$$

3.42 CONTINUED

$$p_A - p_B = \gamma_{OIL}(z_H - z_G - z_A) + \gamma_{Hg}(z_G - z_H)$$

$$\gamma_{OIL} = 0.95 \left(62.3 \frac{LBf}{FT^3}\right)\left(\frac{1\,FT}{12\,IN}\right)^3 = 0.0343 \frac{LBf}{IN^3}$$

$$\gamma_{Hg} = 847 \frac{LBf}{FT^3}\left(\frac{1\,FT}{12\,IN}\right)^3 = 0.490 \frac{LBf}{IN^3}$$

↑ FROM TABLE A.4

$$p_A - p_B = 0.0343\,[-5-(-2)-18] + 0.490\,[-2-(-5)]$$

$$p_A - p_B = -0.720\ psi + 1.47\ psi$$

$$\boxed{p_A - p_B = 0.75\ PSI = 108\ PSF}$$

$$\frac{p_A}{\gamma_{OIL}} - \frac{p_B}{\gamma_{OIL}} = 21.9\ IN. = 1.82\ FT.$$

$$\left(\frac{p_A}{\gamma_{OIL}} + z_A\right) - \left(\frac{p_B}{\gamma_{OIL}} + z_B\right) = 21.9\ IN. + 18\ IN.$$

$$\boxed{\left(\frac{p_A}{\gamma_{OIL}} + z_A\right) - \left(\frac{p_B}{\gamma_{OIL}} + z_B\right) = 39.9\ IN. = 3.33\ FT}$$