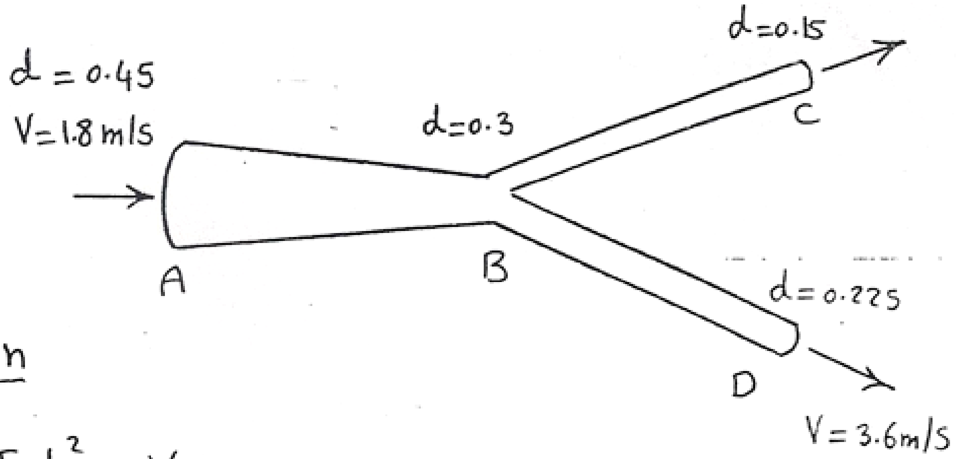
Model Answer of Assignment 5

Question (4):

$Q_C = ?$ $Q_D = ?$

$V_B = ?$ $V_C = ?$



Applying Continuity eqn

$$Q_A = A.V = \frac{\pi d^2}{4} * V$$

$$= \frac{\pi (0.45)^2}{4} * 1.8 = 0.286 \ m^3/s$$

$$Q_D = AV = \frac{\pi (0.225)^2}{4} * 3.6 = \underline{\underline{0.143 \ m^3/s}}$$

$$Q_A = Q_C + Q_D$$

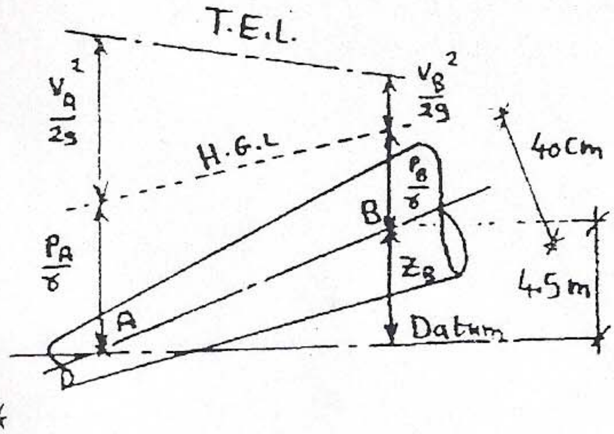
$$0.286 = Q_C + 0.143 \quad \Rightarrow \quad Q_C = \underline{\underline{0.143 \ m^3/s}}$$

$$V_C = \frac{Q_C}{A_C} = \frac{0.143}{\frac{\pi (0.15)^2}{4}} = \underline{\underline{8.09 \ m/s}}$$

$$Q_B = Q_A = 0.286 \ m^3/s$$

$$V_B = \frac{Q_B}{A_B} = \frac{0.286}{\frac{\pi (0.3)^2}{4}} = \underline{\underline{4.04 \ m/s}}$$

Question (5):



$P_A = 0.7\ Kg_w/cm^2$

$= 0.7 * 9.81 \times 10^4 = \underline{68670\ N/m^2}$

$P_B = 0.5\ Kg_w/cm^2$

$= 0.5 \times 9.81 \times 10^4 = \underline{49050\ N/m^2}$

$Q = 150\ lit/sec = 150 \times 10^{-3}\ m^3/s$

$\therefore E_A = \frac{P}{\gamma} + \frac{V^2}{2g} + Z$

$V_A = \frac{Q}{A_A} = \frac{150 \times 10^{-3}}{\frac{\pi (0.15)^2}{4}} = 8.48\ m/s$

Taking a datum at A

Total Energy at A $\quad E_A = \frac{68670}{9810} + \frac{(8.48)^2}{2 * 9.81} + 0 = \underline{\underline{10.67\ m}}$

$V_B = \frac{Q}{A_B} = \frac{150 \times 10^{-3}}{\frac{\pi (0.4)^2}{4}} = 1.19\ m/s$

Total Energy at B $\quad E_B = \frac{49050}{9810} + \frac{(1.19)^2}{2 * 9.81} + 4.5 = \underline{\underline{9.57\ m}}$

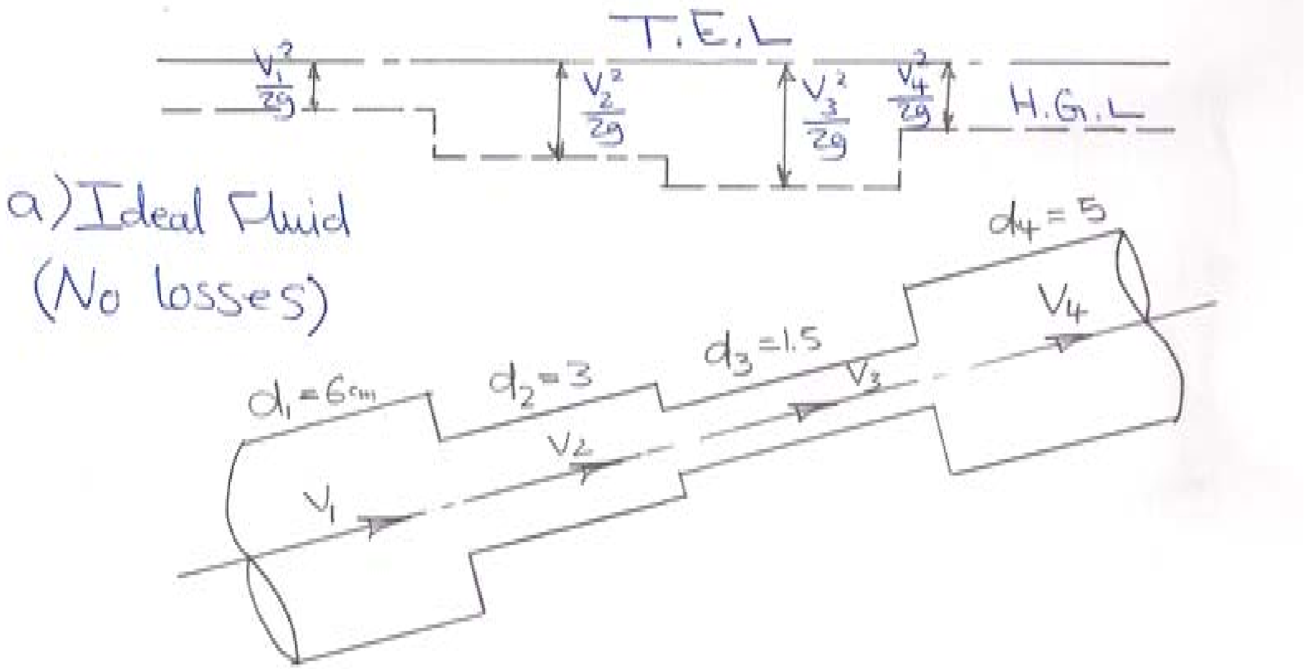
$\because E_A > E_B$

$\therefore$ Water flow from $A \rightarrow B$

head loss = Total Energy at A − Total Energy at B

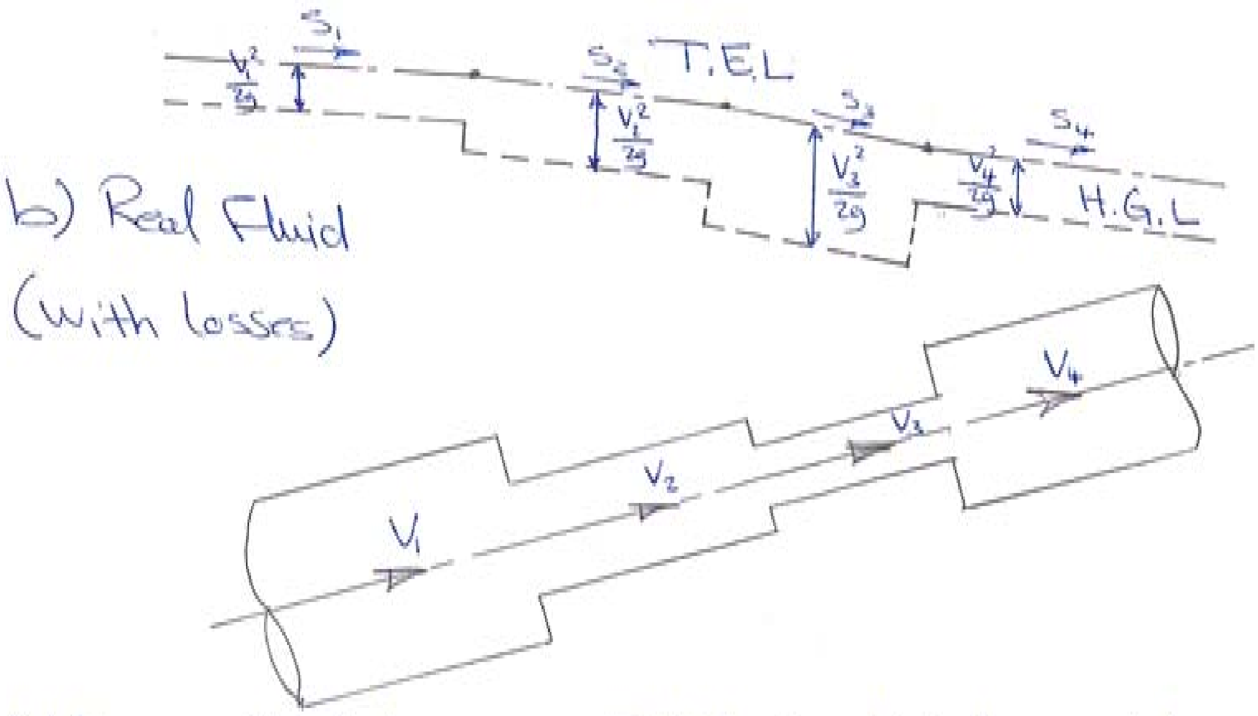
$h_L = E_A - E_B = 10.67 - 9.57 = \underline{\underline{1.1\ m}}$

Question (6):



Note: * For No losses → T.E.L is horizontal

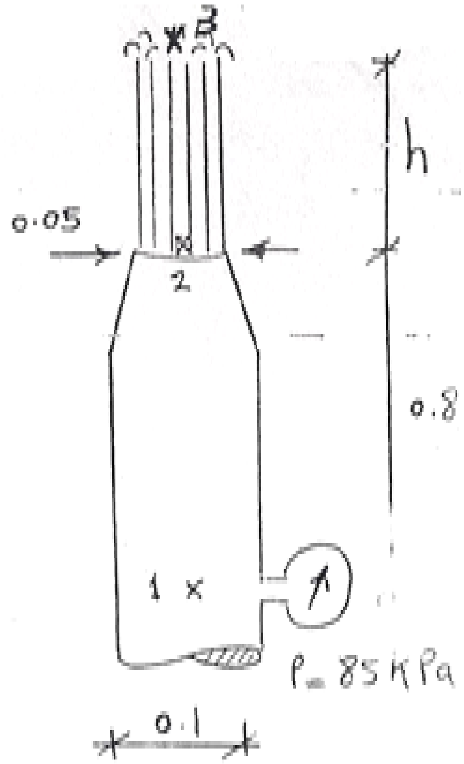
* $d_1 > d_4 > d_2 > d_3 \rightarrow V_1 < V_4 < V_2 < V_3$



Note :- * With losses → T.E.L is Not horizontal

* $V_1 < V_4 < V_2 < V_3 \rightarrow S_1 < S_4 < S_2 < S_3$

Question (7):



$Q = ?$, $h = ?$

Sol

Continuity eqn bet 1, 2

$$d_1^2 V_1 = d_2^2 V_2$$

$$(0.1)^2 V_1 = (0.05)^2 V_2$$

$$V_2 = 4 V_1$$

Bernoulli eqn bet ①, ② datum at ①

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

$$\frac{85 \times 10^3}{9810} + \frac{V_1^2}{2(9.81)} + 0 = 0 + \frac{(4V_1)^2}{2(9.81)} + 0.8$$

$\Rightarrow V_1 = 3.21 \ m/s^2$ $\Rightarrow V_2 = 4 V_1 = 12.82 \ m/s$

$$\Rightarrow Q = V_1 A_1 = 3.21 \frac{\pi (0.1)^2}{4} = \underline{0.025 \ m^3/s}$$

Bernoulli eqn bet ②, ③ datum at ②

$$\frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 = \frac{P_3}{\gamma} + \frac{V_3^2}{2g} + Z_3$$

$$h = \frac{V_2^2}{2g} = \frac{(12.82)^2}{2(9.81)} = \underline{8.37 \ m}$$

Another solution using Newton's eqn

$$V_f^2 = V_{in}^2 - 2gh$$

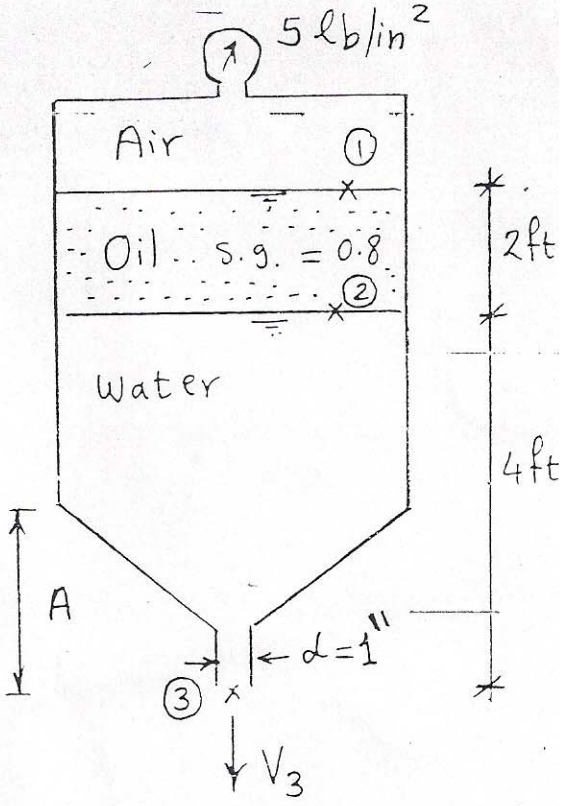
$0 = (12.82)^2 - 2(9.81)h$ $\Rightarrow h = 8.37 m$

Question (8):

$$P_{air} = 5\ \frac{lb}{in^2} = 5 * 144 = 720\ lb/ft^2$$

$V_3 = ?$

Sol.



$$P_2 = P_{air} + \gamma_{oil}\, h_{oil}$$

$$= 720 + 0.8(62.4)2 = 819.8\ \frac{lb}{ft^2}$$

Bernoulli eqn between ②,③ Datum at ③

$$\frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 = \frac{P_3}{\gamma} + \frac{V_3^2}{2g} + Z_3$$

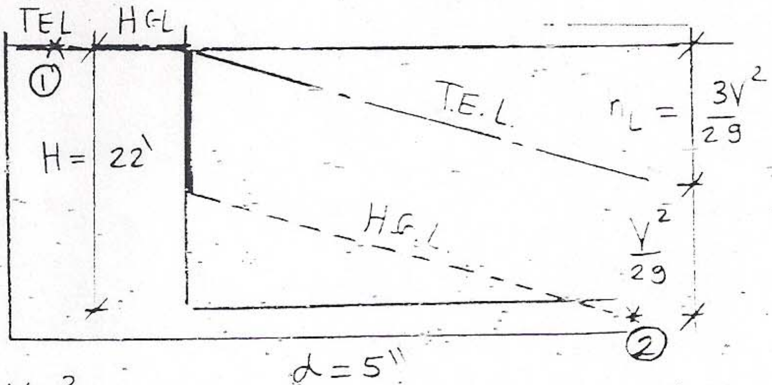
$$\frac{819.8}{62.4} + 4 = \frac{V_3^2}{2(32.2)} \Rightarrow V_3 = 33.2\ ft/s$$

Question (9):

$Q = ?$

Bernoulli eqn between ①,②

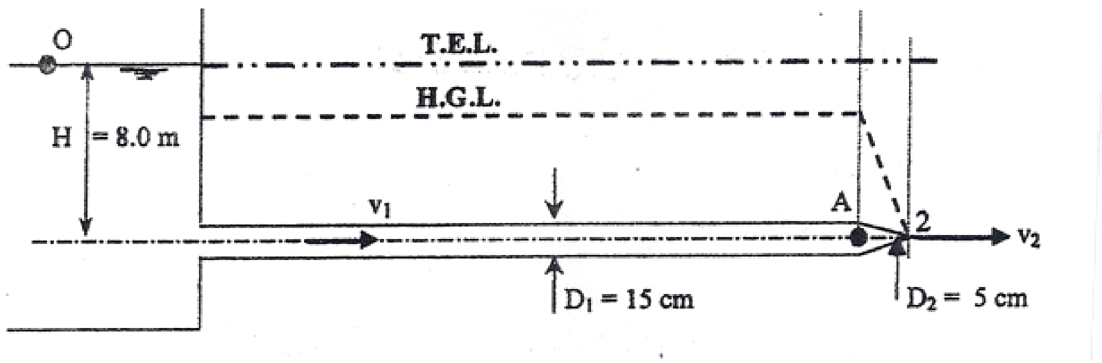
$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + \Sigma h_L$$



$$22 = \frac{V_2^2}{2g} + \frac{3V_2^2}{2g} = \frac{4V_2^2}{2(32.2)} \Rightarrow V_2 = 18.82\ ft/s$$

$$\therefore Q = AV = \frac{\pi (5/12)^2}{4} * 18.82 = 2.56\ ft^3/s$$

Question (10):



a) Case of No-losses

Apply B.E bet (o) & (2) datum at (2)

$8+0+0 = 0+0+\frac{V_2^2}{2g} \longrightarrow V_2 = 12.53\ m/s$

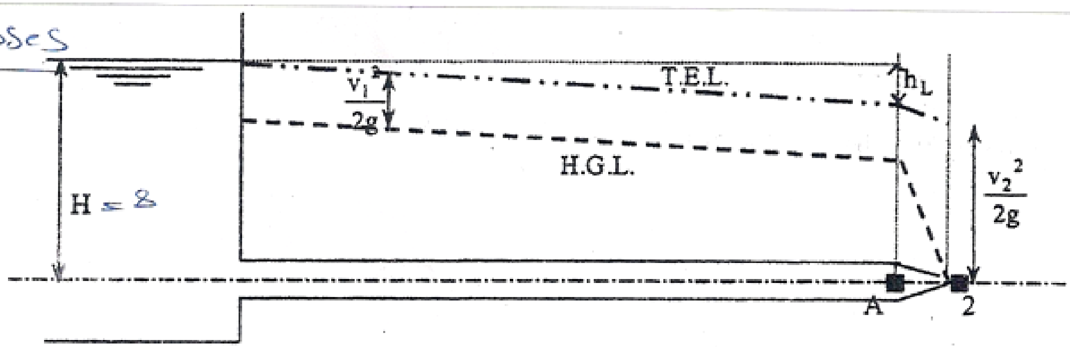
$\therefore Q = A_2 V_2 = \frac{\pi (0.05)^2}{4} * 12.53 = 0.025\ m^3/s$

Apply B.E bet (o) & (A) datum at (A)

$8+0+0 = 0+\frac{P_A}{\gamma}+\frac{V_A^2}{2g}$ where $V_A = V_2 * \left(\frac{D_2}{D_A}\right)^2 = 1.39\ m/s$

$\hookrightarrow P_A = 77513\ Pa$

b) Considering losses



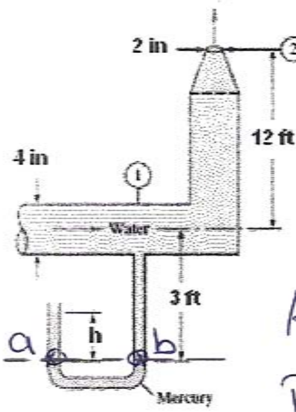
Apply B.E bet (o) & (2) datum at (2)

$8+0+0-\frac{4V_1^2}{2g}-\frac{0.05V_2^2}{2g} = 0+0+\frac{V_2^2}{2g}$ but $V_1 = 9V_2$ ← $\left(\frac{15}{5}\right)^2$

$\hookrightarrow \frac{1}{2g}\left[V_2^2+0.05V_2^2+4(9V_2)^2\right] = 8 \implies V_2 = 11.94\ m/s$

$\hookrightarrow Q = 0.0234\ m^3/s$

Question (11):



$$Q = A_1 V_1 = A_2 V_2$$

$$\to V_2 = V_1 \frac{A_1}{A_2} = V_1 \frac{D_1^2}{D_2^2}$$

$$\therefore V_2 = 2.4\left(\frac{4}{2}\right)^2 = 9.6 \text{ ft/s}$$

Apply B.E bet ①, ② Datum at ①

$$\frac{P_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + Z_2 + \frac{V_2^2}{2g}$$

$$\to \frac{P_1}{\gamma} + 0 + \frac{(2.4)^2}{2 \times 32.2} = 0 + 12 + \frac{(9.6)^2}{2 \times 32.2}$$

$$\to P_1 = 832.52 \text{ lb/ft}^2$$

In Manometer

$$P_a = P_b$$

$$\gamma_{Hg} * h = P_1 + \gamma_w * 3$$

$$\to h = \frac{832.52 + 62.4 \times 3}{13.6 \times 62.4} = \boxed{1.2 \text{ ft}}$$