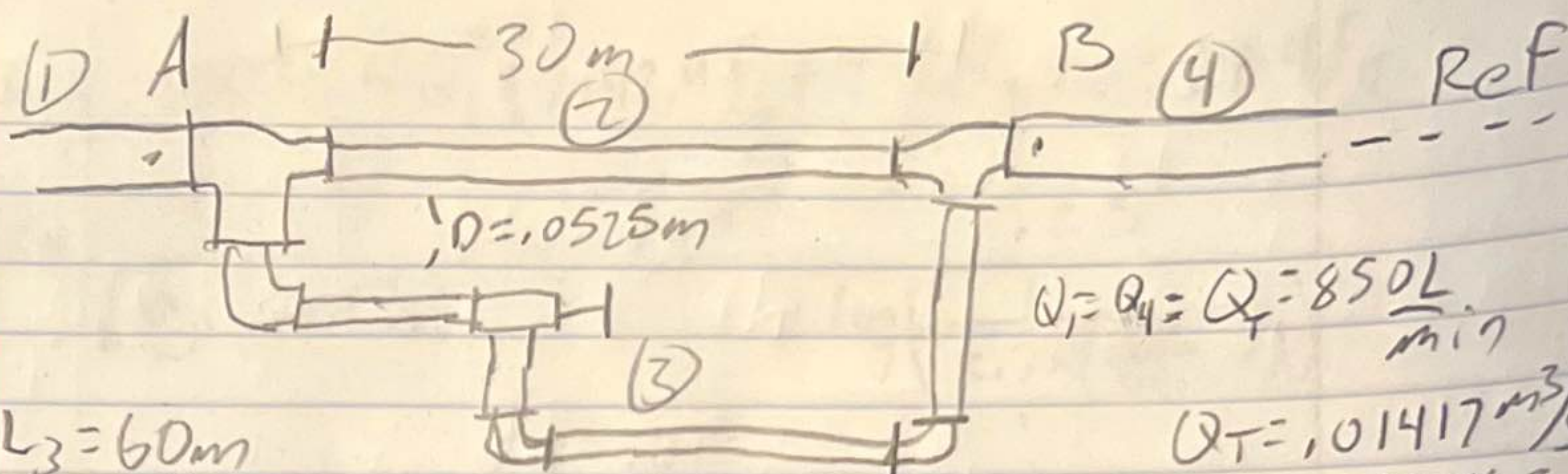


H/W 7

$$D_A = D_B = .1023m$$



$$L_3 = 60m$$

Find: $P_A - P_B$ & Q_2 Q_3

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_{LAB}$$

$$\frac{P_A - P_B}{\gamma} = h_{LAB} \quad h_{L2} = f \frac{L_2}{D_2} \frac{V_2^2}{2g}$$

$$h_{L3} = f_3 \frac{L_3}{D_3} \frac{V_3^2}{2g} + 3K_{elbow} \frac{V_3^2}{2g} + K_{entr} \frac{V_3^2}{2g} + K_{red} \frac{V_3^2}{2g}$$

$$h_{L2} = f_2 \frac{30}{2 \times 9.81 \times .0525} \times \frac{1}{\pi^2 (.0525)^4} \times 16Q^2 + K_V \frac{V_3^2}{2g} + 2K_{tee} \frac{V_1^2}{2g}$$

$$h_{L2} = f_2 Q^2 \times 6.22 \times 10^6 \frac{m^5}{s^2}$$

$$h_{L3} = f_3 \frac{L_3}{9} \frac{8Q^2}{\pi^2 D_3^5} + 3K_{el} \frac{8Q^2}{9\pi^2 D_3^4} + K_{en} \frac{8Q^2}{9\pi^2 D_3^4} + K_{red} \frac{8Q^2}{9\pi^2 D_3^4} + .15K_{tee} + K_V \frac{8Q^2}{9\pi^2 D_3^4}$$

$$h_{L3} = \frac{8Q^2}{9\pi^2 D_3^4} \left(f_3 \frac{L_3}{D_3} + 3K_{elb} + K_{ent} + K_{red} + K_V \right) + .15K_{tee}$$

$$h_{L3} = 10876.4Q^2 (1142.9f_3 + 3K_{elb} + K_{ent} + K_{red} + K_V) + 9f_T$$

$$D_{ratio} = \frac{.1023m}{.0525m} = 1.95 \quad \text{Angle} \sim 30^\circ \quad K_{red} = .04$$

$$K_{elb} = 30f_T \quad K_V = 150f_T$$

$$K_{en} = .46$$

$$K_{tee} = 60f_T$$

$$h_{L3} = 10876.4 Q_3^2 (1142.9 f_3 + 2410 f_T + .5) + 9 f_T$$

$$f_T = \frac{.25}{\left[\log \left(\frac{1}{3.7 (D/\epsilon)} \right) \right]^2} \quad f_T = \frac{.25}{\log \left(\frac{1}{3.7 \times \left(\frac{.0525}{416 \times 10^{-5}} \right)} \right)^2}$$

$$f_T = .019$$

$$h_{L3} = 10876.4 Q_3^2 (1142.9 f_3 + 5.06) + .171$$

$$h_{L2} = 6.22 \times 10^6 f_2 Q_2^2 \quad Q_T = Q_2 + Q_3$$

$$h_{L3} = h_{L2} \quad Q_T - Q_2 = Q_3$$

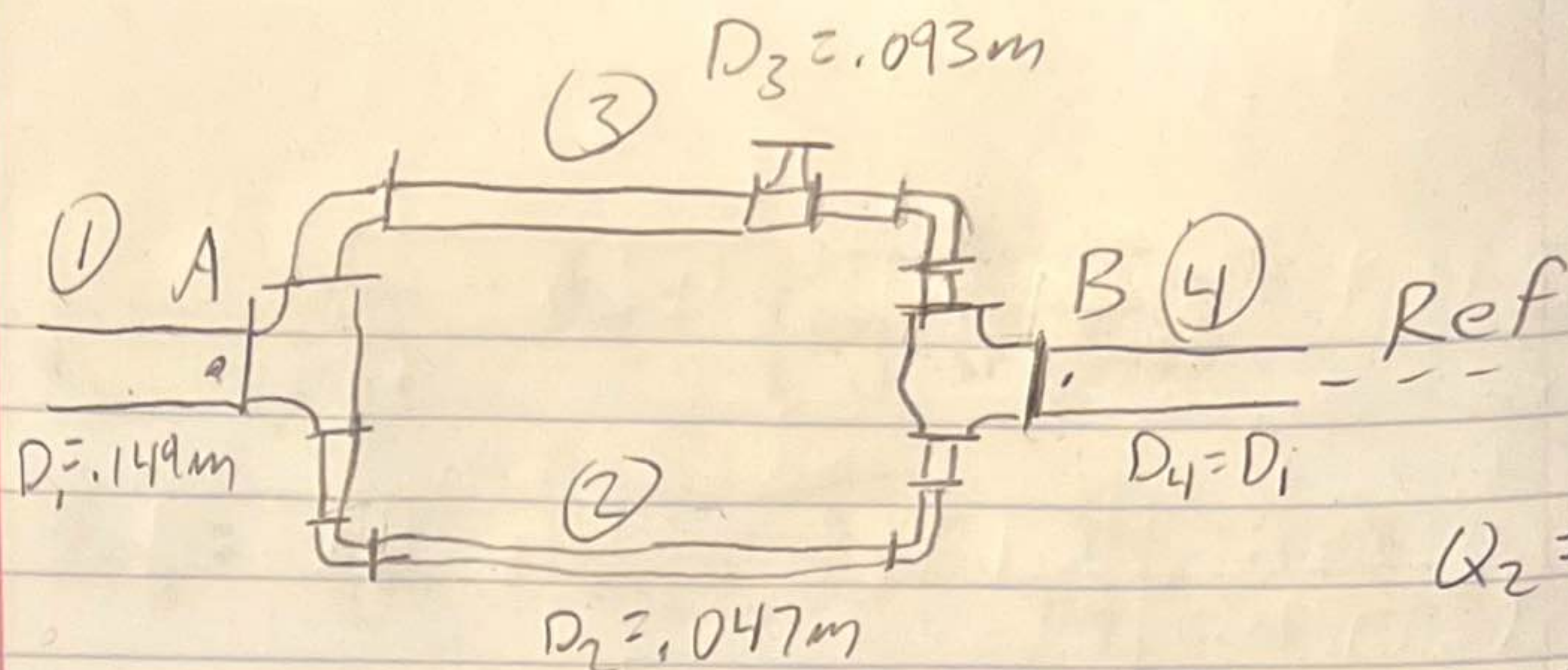
$$6.22 \times 10^6 f_2 Q_2^2 = 10876.4 Q_3^2 (1142.9 f_3 + 5.06) + .171$$

From Excel $Q_2 = .00872 \frac{m^3}{s}$ $Q_3 = .00545 \frac{m^3}{s}$
 $\times 60,000 \frac{L}{min}$
 $\frac{m^3/s}{m^3/s}$ $Q_2 = 523.2 L/min$ $Q_3 = 327 L/min$

$$P_A - P_B = \frac{481 \text{ Pa}}{ms} \left(6.22 \times 10^6 \frac{sec^2}{ms} \times \left(\frac{.00872 m^3}{s} \right)^2 \times .021 \right)$$

$P_A - P_B = 97.43 \text{ KPa}$

12-5



$$\gamma = 9.81 \text{ kN/m}^3$$

$$\nu = 1.3 \times 10^{-6} \text{ m}^2/\text{sec}$$

$$\epsilon = 1.5 \times 10^{-6} \text{ m}$$

$$L_2 = L_3 = 30 \text{ m}$$

$$Q_2 = Q_3 = 500 \frac{\text{L}}{\text{min}}$$

$$Q_2 = Q_3 = 0.0083 \frac{\text{m}^3}{\text{s}}$$

$$Q_1 = Q_4 = 2Q_2$$

$$Q_1 = 0.0167 \frac{\text{m}^3}{\text{s}}$$

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + \frac{z_A}{\gamma} = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + \frac{z_B}{\gamma} + h_{LAB}$$

$$A = \frac{\pi D^2}{4}$$

$$V = Q/A$$

$$V_2 = 0.0083 / (\pi (0.047)^2 / 4) \quad V_2 = 4.178 \frac{\text{m}}{\text{s}}$$

$$V_3 = 0.0083 / (\pi (0.093)^2 / 4) \quad V_3 = 1.22 \frac{\text{m}}{\text{s}}$$

$$\frac{P_A - P_B}{\gamma} = h_{LAB}$$

$$h_{L3} = K_V \frac{V_3^2}{2g} + 2K_{elb} \frac{V_3^2}{2g} + f_3 \frac{L_3}{D_3} \frac{V_3^2}{2g} + 2K_{tee} \frac{V_1^2}{2g}$$

$$+ K_{red} \frac{V_3^2}{2g} + K_{en} \frac{V_3^2}{2g}$$

$$h_{L2} = f_2 \frac{L_2}{D_2} \frac{V_2^2}{2g} + 2K_{elb} \frac{V_2^2}{2g} + K_{red} \frac{V_2^2}{2g} + K_{en} \frac{V_2^2}{2g} + 2K_{tee} \frac{V_1^2}{2g}$$

$$h_{L3} = K_V \frac{8Q_3^2}{\pi^2 D_3^5} + f_3 \frac{L_3}{D_3^5} \frac{8Q_3^2}{\pi^2 g} + \frac{K_{elb} 16Q_3^2}{\pi^2 g D_3^5} + \frac{K_{red} 8Q_3^2}{\pi^2 g D_3^5} + \frac{K_{en} 8Q_3^2}{\pi^2 g D_3^5}$$

$$+ \frac{K_{tee} 16Q_1^2}{\pi^2 g D_1^5}$$

$$h_{L2} = \frac{f_2 L_2 8Q_2^2}{\pi^2 g D_2^5} + \frac{K_{elb} 16Q_2^2}{\pi^2 g D_2^5} + \frac{K_{red} 8Q_2^2}{\pi^2 g D_2^5} + \frac{K_{en} 8Q_2^2}{\pi^2 g D_2^5} + \frac{K_{tee} 16Q_1^2}{\pi^2 g D_1^5}$$

$$K_{elb} = 30f_T \quad f_T = \frac{.25}{\left[\log\left(\frac{1}{3.7 \sqrt{P/\epsilon}} \right) \right]^2}$$

$$K_{tee} = 60f_T$$

$$f_{T1} = \frac{.25}{\left[\log\left(\frac{1}{3.7 \times \left(\frac{.149}{.0000015} \right)} \right) \right]^2} \quad f_{T1} = .0081$$

$$f_{T2} = .00475$$

$$f_{T3} = .0087$$

Diameter ratio $\frac{D_1}{D_3} = 1.6$ $\frac{D_1}{D_2} = 3.2$ Assume 30°

$$K_{ed3} = .045$$

$$K_{en3} = .41$$

$$K_{ed2} = .05$$

$$K_{en2} = .48$$

(excl) $f_2 = .016$ $f_3 = .018$

$$h_{L2} = h_{L3}$$

$$h_{L2} = 11.91m + .68m + .05m + .56m + .045m \quad h_{L2} = 13.25m$$

$$h_{L3} = .076K_V + .442m + .04m + .003m + .031m + .045m$$

$$h_{L3} = .076K_V + .561m = 13.25m$$

$$K_V = 166.96$$