3.37

3.37 Water flows from the large open tank shown in Fig. P3.37. If viscous effects are neglected, determine the heights, h_1, h_2, and h_3, to which the three streams rise.

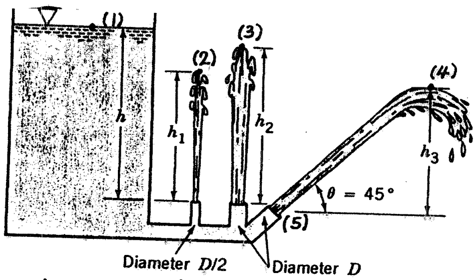

FIGURE P3.37

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$ where $z_1 = h$, $z_2 = h_1$, $p_1 = p_2 = 0$ and $V_1 = V_2 = 0$

Thus,

$$\underline{\underline{h_1 = h}}$$

Similarly, since

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_3}{\gamma} + \frac{V_3^2}{2g} + z_3$$ with $z_3 = h_2$ and $V_3 = 0$

$$\underline{\underline{h_2 = h}}$$

Also,

$$\frac{p_4}{\gamma} + \frac{V_4^2}{2g} + z_4 = \frac{p_5}{\gamma} + \frac{V_5^2}{2g} + z_5$$ with $p_4 = p_5 = 0$, $z_5 = 0$ and $z_4 = h_3$

or

$$h_3 = \frac{V_5^2}{2g} - \frac{V_4^2}{2g} \qquad (1)$$

but $V_5 = \sqrt{2gh}$ and $V_4^2 = V_{4x}^2 + V_{4y}^2 = V_{4x}^2$ since $V_{4y} = 0$

also

$V_{4x} = V_{5x}$ since the acceleration in the horizontal direction is zero.

Thus, $V_{4x} = V_5 \cos\theta = \sqrt{2gh}\cos\theta$, $V_{5y} = \sqrt{2gh}\sin\theta$

so that Eq. (1) becomes

$$h_3 = \frac{V_{5x}^2 + V_{5y}^2}{2g} - \frac{V_{4x}^2 + V_{4y}^2}{2g} = \frac{1}{2g}V_{5y}^2 = \frac{1}{2g}(2gh)\sin^2\theta$$

or

$$h_3 = h\sin^2\theta = h\sin^2 45° = \underline{\underline{0.5\,h}}$$