1) $V_2 = V_1 (D_1/D_2)^2$

$= 0.5 (\frac{8}{2.5})^2$

$= 5.12$ m/s

$P_1 + \frac{\rho}{2} V_1^2 + \rho g z_1$ ($z_1 \to 0$)

$= P_2 + \frac{\rho}{2} V_2^2 + \rho g z_2$ ($P_2 \to 0$)

$P_1 + \frac{998}{2}(0.5)^2$

$= \frac{998}{2}(5.12)^2 + 998(9.81)(3)$

$P_1 = 998(-0.5^3 + \frac{5.12^2}{2} + 9.81 \times 3)$

$= 42327.376$ Pa

$P_1 + P_{water} g (0.6) = P_{merc} g h$

$h = \frac{P_w g (0.6) + P_1}{P_m g}$

$= \frac{998 \times 9.81 (0.6) + 42327.376}{(13550)(9.81)}$

$= 0.3626$ m

∴ The velocity at section 2 is 5.12 m/s

∴ The height of manometer at section 1 is 0.3626 m

2) $P_1 - P_0 = \frac{\rho}{2} V_{jet}^2 [1 - (\frac{D_{jet}}{D_1})^4]$

$= 110000 - 101350 = \frac{998}{2} V_{jet}^2 [1 - (\frac{4}{12})^4]$

$\therefore V_{jet} = \sqrt{\frac{2(P_1 - P_0)}{\rho [1 - (\frac{D_{jet}}{D_1})^4]}}$

$= \frac{2 \times (110000 - 101350)}{998 \times (1 - (\frac{4}{12})^4)}$

$= 4.19$ m/s

$\dot{m} = \rho A V_{jet} = 998 \frac{\pi}{4} (0.04)^2 (4.19)$

$= 5.25 \frac{kg}{s}$

$H = \frac{V_{jet}^2}{2g} = \frac{(4.19)^2}{2(9.81)}$

$= 0.89$ m

∴ The mass flow is 5.25 kg/s

∴ The height is 0.89 m

3) $\Sigma F = F = -\dot{m}_{in} u_{in} = -\rho A_2 V_2^2$

$70 = -998 \frac{\pi}{4} 0.03^2 V_2^2$

$\therefore V_2 = 9.96 \text{ m/s}$

$V_1 = \frac{V_2 A_2}{A_1} = \frac{9.96 \frac{\pi}{4} 0.03^2}{\frac{\pi}{4}(0.1)^2}$

$= 0.9 \text{ m/s}$

$P_2 - P_1 = \frac{\rho}{2}(V_2^2 - V_1^2)$

$= \frac{998}{2}(9.96^2 - 0.9^2)$

$= 49100 \text{ Pa}$

$h = \frac{\Delta P}{\Delta \rho g} = \frac{49100}{(133100 - 9780)}$

$= 0.4 \text{ m}$

∴ Velocity at Sections 1 and 2 are 0.9 m/s and 9.96 m/s respectively

∴ The reading is 0.4 m

4) $\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2$

$P_1 - P_2 = \rho_{air} \frac{V_2^2 - V_1^2}{2} + \rho g (z_2 - z_1)$

$\rho_{air} = \frac{P}{RT} = \frac{105}{(0.287)(37+273)}$

$= 1.180 \text{ kg/m}^3$

$V_1 = \frac{\dot{V}}{A_1} = \frac{0.065}{(\pi)(0.06)^2/4} = 22.98 \text{ m/s}$

$V_2 = \frac{\dot{V}}{A_2} = \frac{0.065}{\pi(0.04)^2/4} = 51.73 \text{ m/s}$

$P_1 - P_2 = (1.18)\left[\frac{51.73^2 - 22.98^2}{2} + 9.81 \times 0.2\right] = 1269.31 \text{ Pa}$

$h = \frac{\Delta P}{\rho_N g} = \frac{1269.31}{1000 \times 9.81} = 0.1293 \text{ m}$

$= 12.9 \text{ cm}$

∴ The differential height is 12.9 cm