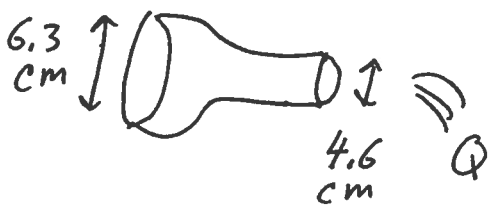
Pipe Diameter Change



$Q = \frac{2.2\ m^3}{(4)(60\ sec)}$

$6.3\,cm = .063\,m$
$4.6\,cm = .046\,m$ } $R = \frac{D}{2}$

$R_B = \frac{.063}{2}$ (BIG) $\quad R_S = \frac{.046}{2}$ (SMALL)

Area $A = \pi R^2$

$vA = const \Rightarrow v_B \pi R_B^2 = v_S \pi R_S^2 = Q$

① $v_B = \frac{Q}{\pi R_B^2} = \frac{2.2}{(4)(60)} \frac{1}{\pi} \left(\frac{2}{.063}\right)^2 = \boxed{2.94 \frac{m}{s}}$

2.9406

② $P_B + \frac{1}{2}\rho v_B^2 = P_S + \frac{1}{2}\rho v_S^2$

need $v_S = \frac{Q}{\pi R_S^2} = \frac{(2.2)(2)^2}{(4)(60)(\pi)(.046)^2} =$

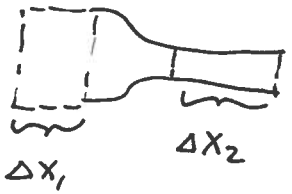
$= 5.5158\ m/s$

$\Delta P = \frac{1}{2}\rho \left(v_S^2 - v_B^2\right) = 500\left(2.94^2 - 5.516^2\right)$ *

$= 10.9\ kPa \quad | = 10.9E3$

should be $(5.516^2 - 2.94^2)$

③ Recall derivation of $v_1 A_1 = v_2 A_2$

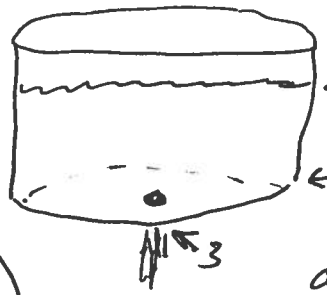


$Q = A_1 \frac{\Delta x_1}{\Delta t} = A_2 \frac{\Delta x_2}{\Delta t}$ (same)

$\frac{\Delta x_2}{\Delta x_1} = \frac{A_1}{A_2} = \frac{v_2}{v_1} \rightarrow \Delta x_S = \frac{5.5158}{2.94} \times 33\ mm$

(small Pipe) $= 61.9$ mm separation in fast pipe

④



Water not moving much near small hole (not until you are within a few hole diameters of hole)

$P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$

$= P_3 + \rho g h_3 + v_3^2$

Let: $P_1 = 0 \quad h_1 = 7.7m$.

$v_1 = v_2 = 0$ and $h_2 = h_3 = 0$

$\rho g h_1 = \frac{1}{2}\rho v_3^2$

$v_3 = \sqrt{2gh_1} = \sqrt{2(9.8)(7.7)}$

$= 12.3\ m/s$