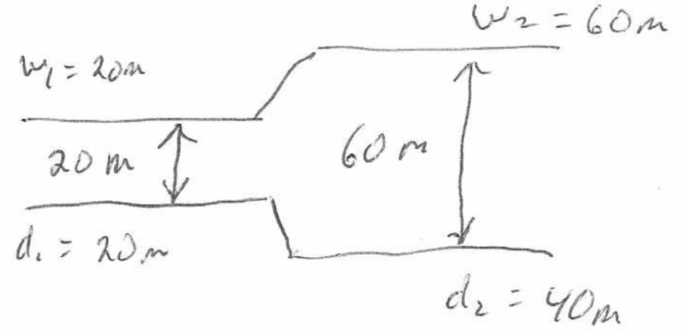
1)



$Q = 300{,}000\ l/\cancel{m}s$

$= 300\ m^3/s$

a) Area $A_1 = 20 \times 20 = 400\ m^2$

speed of River?

use $Q = vA$

$\cancel{A_1 =}$ $V_1 = \dfrac{Q}{A_1} = \dfrac{300\ m^3/s}{400m^2} = 0.75\ M/s$

b) Area $A_2 = 60 \times 40m^2 = 2400m^2$

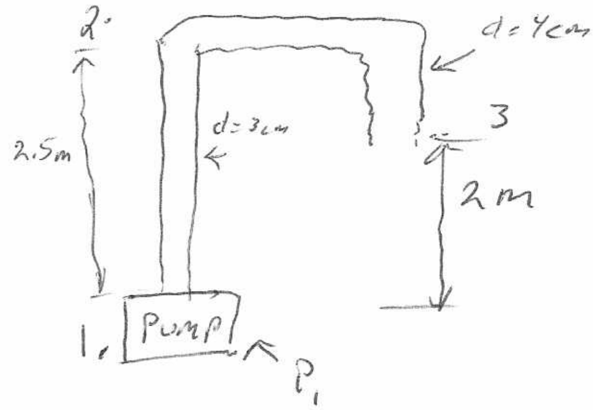
$V_2 = \dfrac{Q}{A_2} = \dfrac{300m^3/s}{2400\ m^2} = 0.125\ m/s$

2.)

$Q = 0.75\ l/s = 0.75 \times 10^{-3}\ m^3/s$

$P_{pump} = 3.00 \times 10^{5}\ N/m^2$

$\rho_w = 10^3\ kg/m^3 \quad , \quad g = 9.8\ m/s^2$



a) Pressure at top of hose?

Use Bernoulli's equation : choose 2 points

point 1 at pump

point 2 at top of hose

$$P_1 + \tfrac{1}{2}\cancel{\rho_1 v_1^2}^{\,0} + \cancel{\rho g y_1}^{\,0} = P_2 + \tfrac{1}{2}\rho_2 v_2^2 + \rho g y_2$$

need v_2 : use $Q = vA$ $\qquad r_2 = 1.5cm = 0.015m$

$$v_2 = \frac{Q}{A_2} = \frac{Q}{\pi r_2^2} = \frac{0.75 \times 10^{-3}\ m^3/s}{\pi\,(0.015m)^2} = 1.06\ m/s$$

$P_1 = \cancel{10}\ 3.00 \times 10^5\ N/m^2 \qquad P_2 = ?$

$v_1 = 0 \qquad v_2 = 1.06\ m/s$

$y_1 = 0 \qquad y_2 = 2.5\ m$

$$P_2 = \underbrace{P_1}_{\text{original pressure}} - \underbrace{\tfrac{1}{2}\rho_2 v_2^2}_{\text{drop due to flow}} - \underbrace{\rho g y_2}_{\text{drop due to elevation rise}}$$

$$P_2 = 3.00 \times 10^5\ N/m^2 - \tfrac{1}{2}\,10^3\ kg/m^3\,(1.06\ m/s)^2 - 10^3\ kg/m^3\ 9.8\ m/s^2\ 2.5m$$

$$P_2 = 3.00 \times 10^5\ N/m^2 - 0.0053 \times 10^5\ N/m^2 - 0.245\ N/m^2$$

$$P_2 = 2.75 \times 10^5\ N/m^2$$

2)

b) Pressure at point 3? $\qquad y_3 = 2.0\,m$

$d_3 = 4\,cm = 0.04\,m$

need Velocity at point 3 $\qquad r_3 = 0.02\,m$

$$V_3 = \frac{Q}{A_3} = \frac{0.75 \times 10^{-3}\,m^3/s}{\pi (0.02\,m)^2} = \cancel{5.97\,m}\ 0.6\,m/s$$

use P_1 + P_3 in Bernoulli's eq.

$$P_1 + \cancel{\tfrac{1}{2}\rho v_1^2}^{\,0} + \cancel{\rho g y_1}^{\,0} = P_3 + \tfrac{1}{2}\rho v_3^2 + \rho g y_3$$

$$P_3 = P_1 - \tfrac{1}{2}\rho v_3^2 - \rho g y_3$$

$$P_3 = 3.00 \times 10^5\,N/m^2 - \tfrac{1}{2}\,10^3\,kg/m^3\,(0.6\,m/s)^2 - 10^3\,kg/m^3\; 9.8\,m/s^2\; 2.0\,m$$

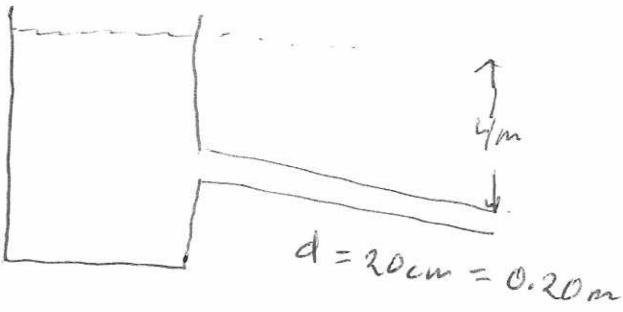
$$P_3 = 3.00 \times 10^5\,N/m^2 - 0.0018\,N/m^2 - 0.196 \times 10^5\,N/m^2$$

$$P_3 = 2.8 \times 10^5\,N/m^2$$

3.)

$\rho_w = 10^3\ kg/m^3$

$g = 9.8\ m/s^2$



a) speed of water out of pipe?

Use Bernoullis equation

Point 1 = top of water in tank

Point 2 = outlet of pipe

$y_1 = 4m$ $\quad y_2 = 0.0m$

$v_1 = 0$ $\quad v_2 = ?$

$P_1 = 1\ atm$ $\quad P_2 = 1\ atm$ ← Both open to atmosphere

$$P_1 + \cancel{\tfrac{1}{2}\rho v_1^2}^{\,0} + \rho g y_1 = P_2 + \tfrac{1}{2}\rho v_2^2 + \cancel{\rho g y_2}^{\,0}$$

$$\tfrac{1}{2}\rho v_2^2 = \cancel{P_1 - P_2}^{\,0} + \rho g y_1$$

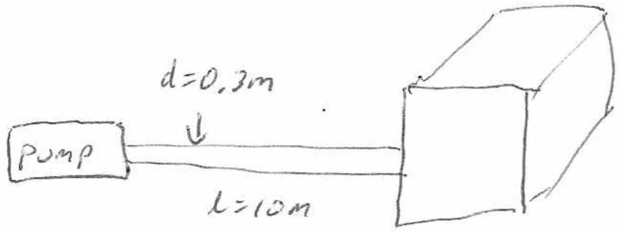
$$v_2^2 = 2 g y_1 \qquad v_2 = (2 \times 9.8 m/s^2 \cdot 4m)^{1/2}$$

$$v_2 = 8.85 m/s$$

b) $Q = vA = 8.85 m/s \cdot \pi (0.10m)^2 = 2.78\ m^3/s$

4)

$\eta_{air} = 0.0181 \times 10^{-3}$ Pa·s



Volume = 13.0m × 20.0m × 2.75m

Volume = 715 m^3

a) $Q = vA$

find v = speed in duct

$$Q = \frac{\text{Volume house}}{15\,\text{min}} = \frac{715\,m^3}{15\,\text{min} \times 60\,\frac{\text{sec}}{\text{min}}} = 0.79\,m^3/s$$

b) Resistance to flow in the duct:

$$R = \frac{8\eta l}{\pi r^4}$$

$l = 10.0$m

$r = 0.15$m

$\eta = 0.0181 \times 10^{-3}$ Pa.s

$$R = \frac{8 \cdot 0.0181 \times 10^{-3} \cdot 10.0\,m}{\pi\,(0.15\,m)^4} = 2.86\,\frac{Pa \cdot s}{m^3}$$

c) Pressure Drop ΔP?

$$\Delta P = RQ = 2.86\,\frac{Pa \cdot s}{m^3} \cdot 0.79\,m^3/s$$

$$\Delta P = 2.26\,Pa$$