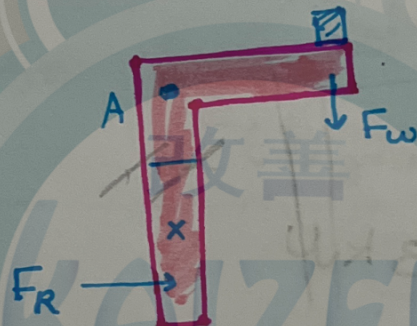
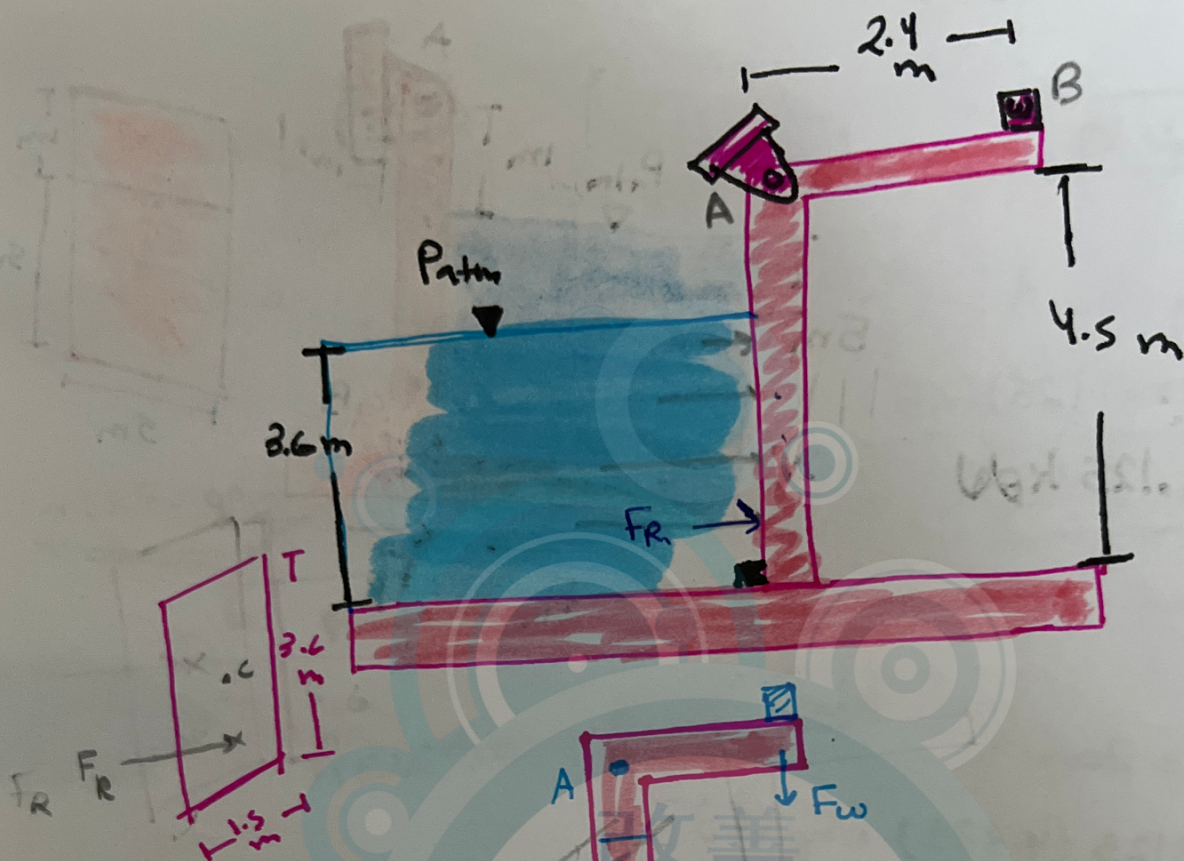




$$F_R = 1000 \times 9.81 \times 1.8 = 6.4$$

$$F_R = 95353.2 \text{ N}$$

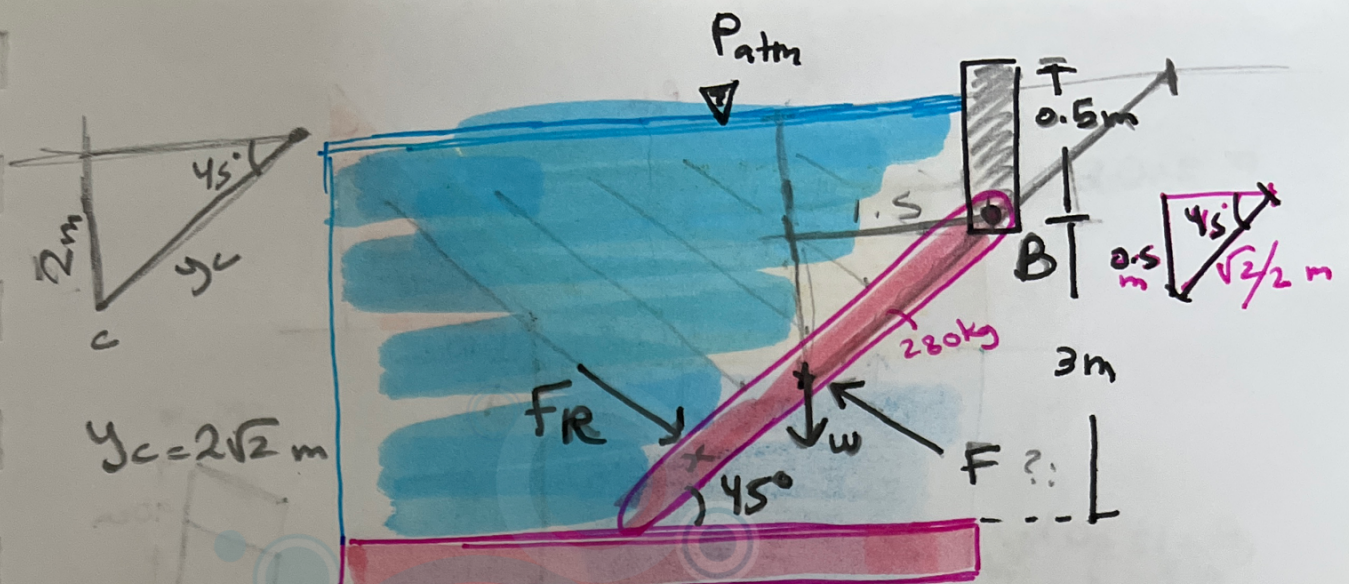
$$y_P = 2.4 \text{ m}$$

$$\sum M_A = \text{zero}$$

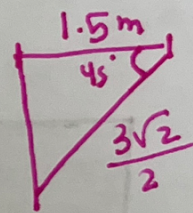
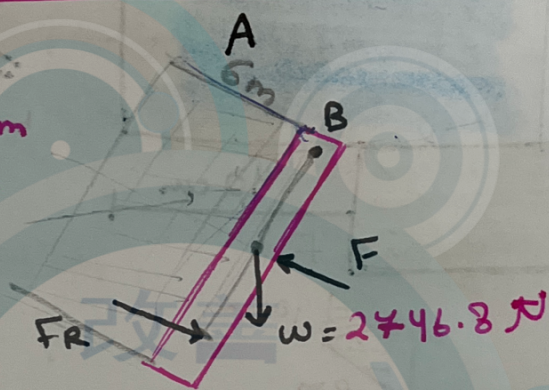
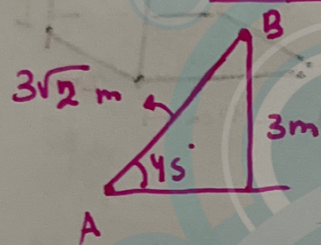
$$0 = F_w (2.4) - 95353.2 (3.3)$$

$$F_w = 131110.65 \text{ N}$$

$$m = \frac{131110.65}{9.81} = 13365 \text{ kg}$$



$$y_c = 2\sqrt{2} \text{ m}$$



$$h_c = 0.5 + 1.5 = 2 \text{ m}$$

$$F_R = (1000)(9.81) 2 (6 \times 3\sqrt{2}) = 499443.662 \text{ N}$$

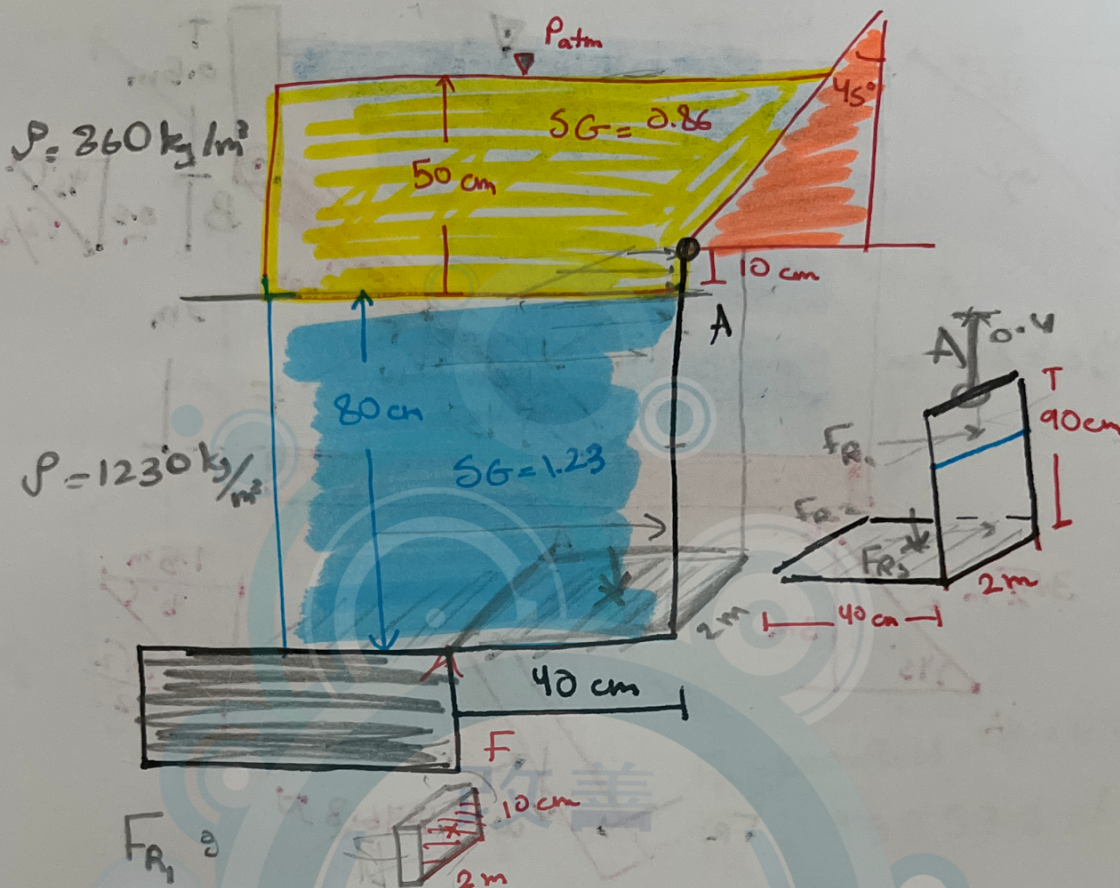
$$y_p = 2\sqrt{2} + \frac{\frac{1}{12} (3\sqrt{2})^3 (6)}{2\sqrt{2} (6 \times 3\sqrt{2})} = 3.3587 \text{ m}$$

$$\sum M_B = 0$$

$$0 = -499443.662 (2.6518) - 2746.8 (1.5) + F \left(\frac{3\sqrt{2}}{2} \right)$$

~~$$F = 792.7 \text{ kN}$$~~

$$F = 626.23 \text{ kN}$$



$$FR_1 = 860 (9.81) (40 + 5) \times 10^{-2} (2 \times 0.1)$$

$$= 759.294 \text{ N} \quad \text{--- ①}$$

$$FR_2 = P_0 \cdot A_2$$

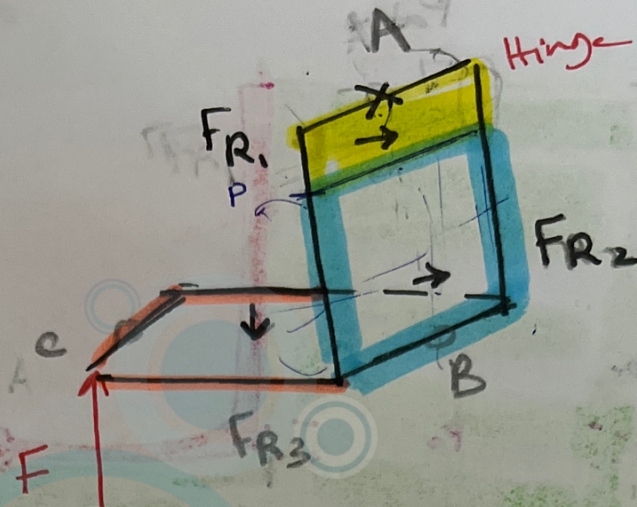
$$\oplus \rho g h_{c_2} \cdot A_2$$

Diagram showing a vertical rectangular block with a height of 40 cm and a width of 2 m. The top surface is at a depth of 20 cm. The force FR_2 acts on the right side of the block.

$$FR_2 = 4218.3 (1.6) + 1230 (9.81) 0.4 (1.6) = 14471.7 \text{ N}$$

$$FR_3 = \underbrace{9.81 (1230) (0.8) (0.4 \times 2)}_{F_{\text{fluid 2}}} + \underbrace{4218.3 (0.4 \times 2)}_{F_{\text{fluid 1}}}$$

$$FR_3 = 11097.072 \text{ N}$$

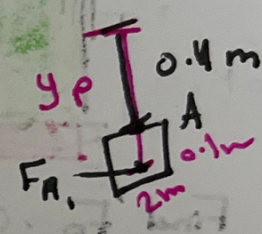


$\sum M_A = \text{Zero}$

$y_{P1} = 0.452 \text{ m}$

$y_{P2} = 0.533 \text{ m}$

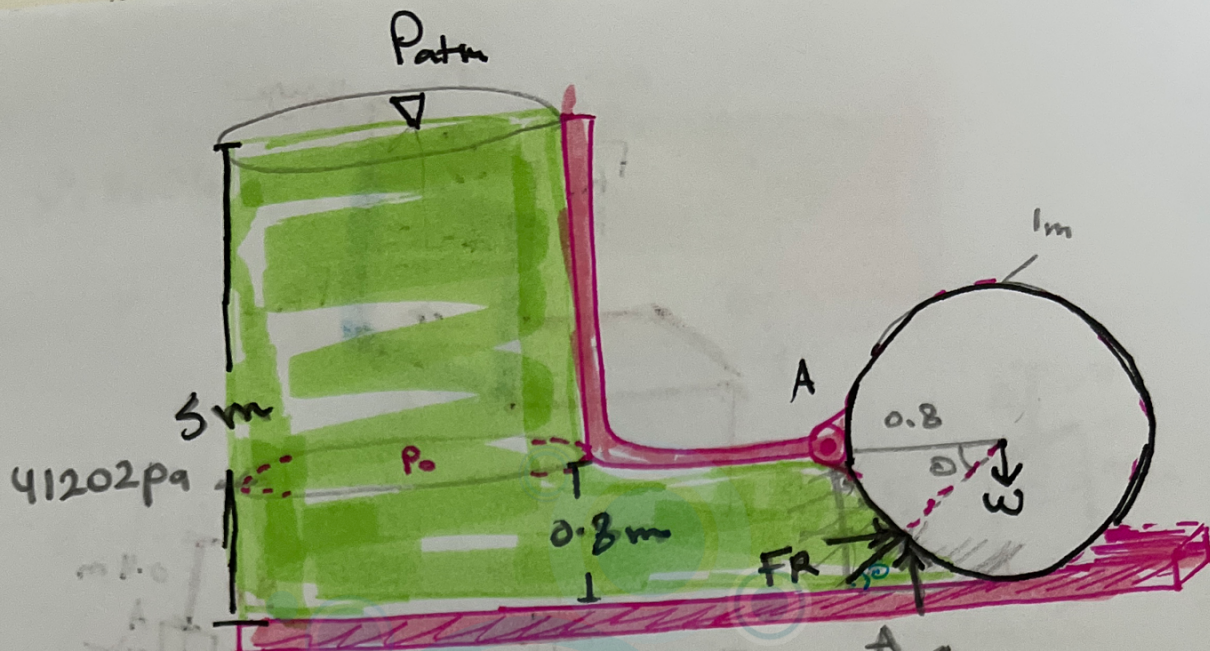
$\sum M_A = \text{Zero}$



$$0 = -759.294 (0.452 - 0.4) - 14471.7 (0.533 + 0.1) - 0.2 (11097.072) + 0.4 F$$

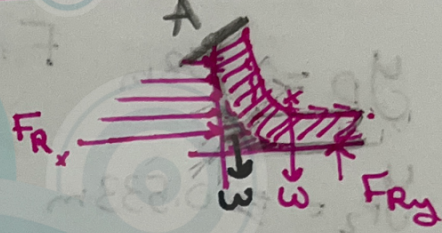
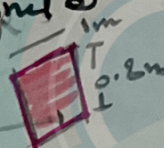
$F = 28.56 \text{ kN}$

$0.2 \times 0.1 = 0.02$



Find F_R and ω

$F_{Rx} =$



$$F_{Rx} = 41202 \times (0.8) + 1000(9.81) 0.4 (0.8)$$

$$F_{Rx} = 36.1008 \text{ kN}$$

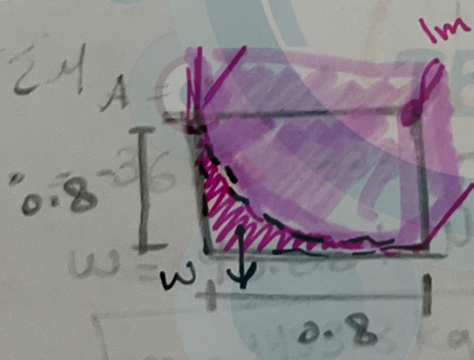
$$y_P = 0.533 \text{ m}$$

$$1 \times 0.8 = 0.8 \text{ m}^2$$

$$F_{Ry} = 39.24 \text{ kN}$$



$$F_{Ry} = 52.34 \text{ kN}$$



$$\text{Volume of fluid} = 0.1373 \text{ m}^3$$

$$W = 1.3 \text{ kN}$$

$$F_{hyd} = F_{Rx} \hat{i} + (F_{Ry} - W_{fluid}) \hat{j} = 36.1008 \hat{i} + 37.89 \hat{j}$$

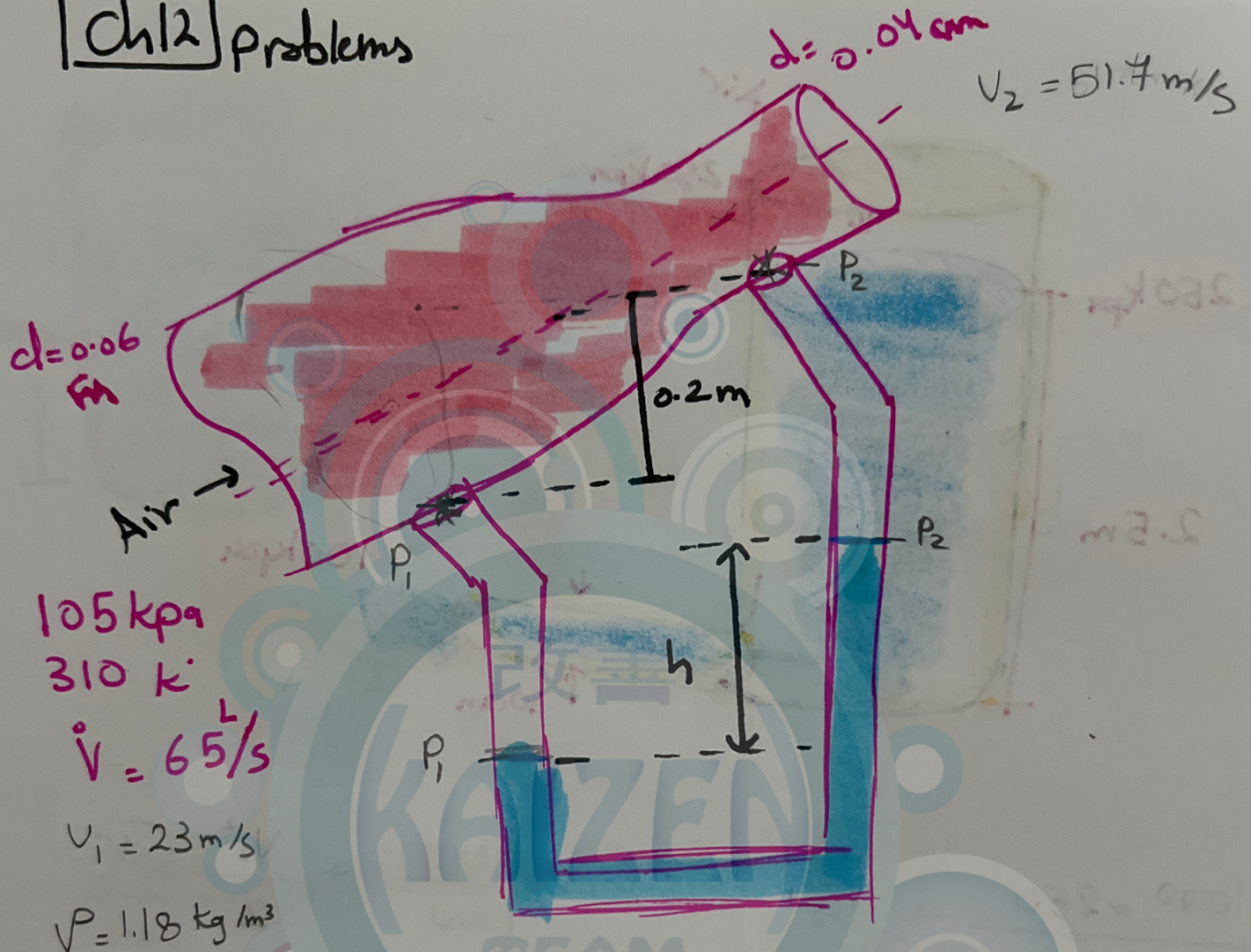
$$F_{R(hyd)} = 52.34 \text{ kN}$$

$$\theta = 46.4^\circ$$

$$m = \frac{37.4 \times 1000}{9.81}$$

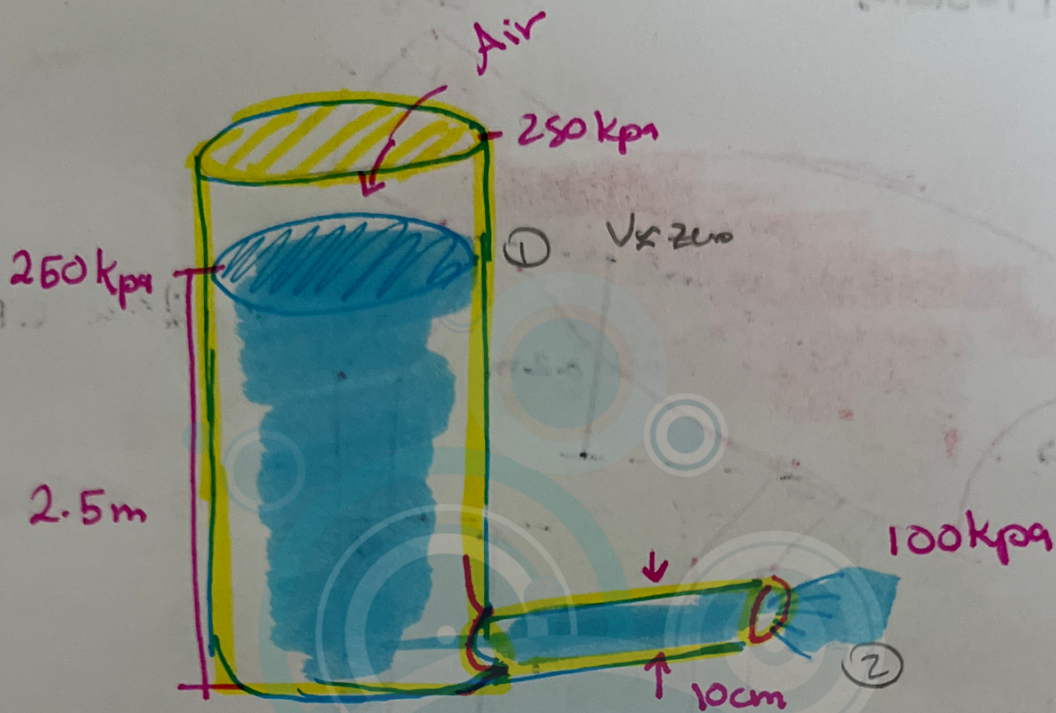
Watermarkly

Ch12 Problems



$$(P_1 - P_2) = \rho \left(\frac{V_2^2 - V_1^2}{2} + g(z_2 - z_1) \right) = 1267.21 \text{ Pa}$$

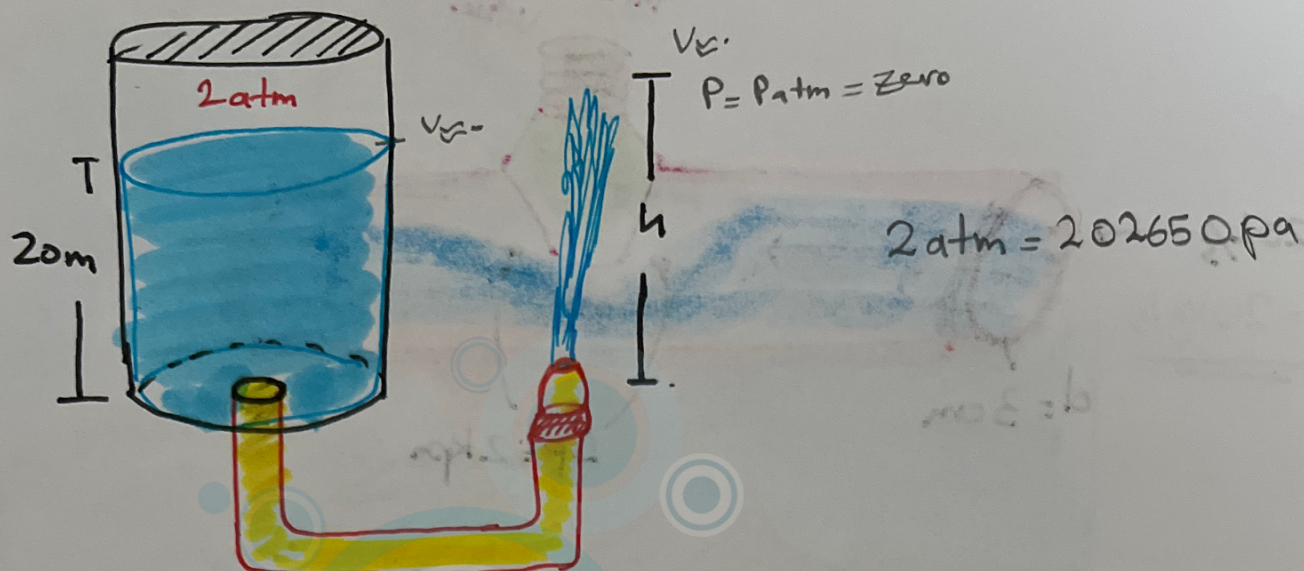
$$P_1 = P_2 + \rho g(h) \rightarrow h = 0.129 \text{ m}$$



$$\frac{1000 \times 250}{1000} + 9.81 (2.5) = \frac{100 \times 1000}{1000} + \frac{V_2^2}{2} + 9.81$$

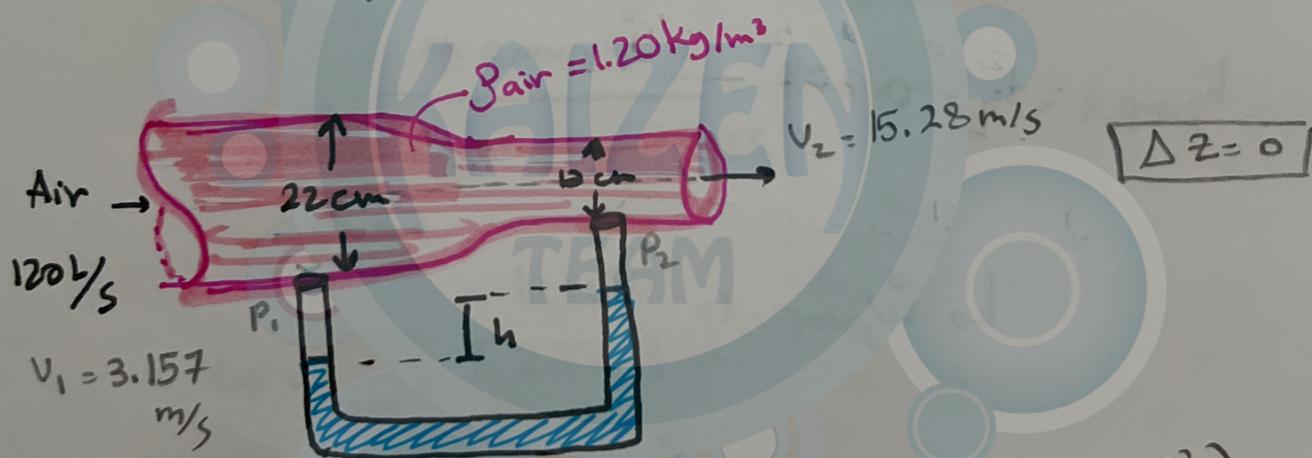
$$V_2 = 18.68 \text{ m/s}$$

$$\dot{V} = 18.68 \times \frac{\pi}{4} (0.1)^2 = 0.147 \text{ m}^3/\text{s}$$



$$\frac{202650}{1000} + 9.81(20) = 9.81(h)$$

$$\rightarrow h = 40.66 \text{ m}$$

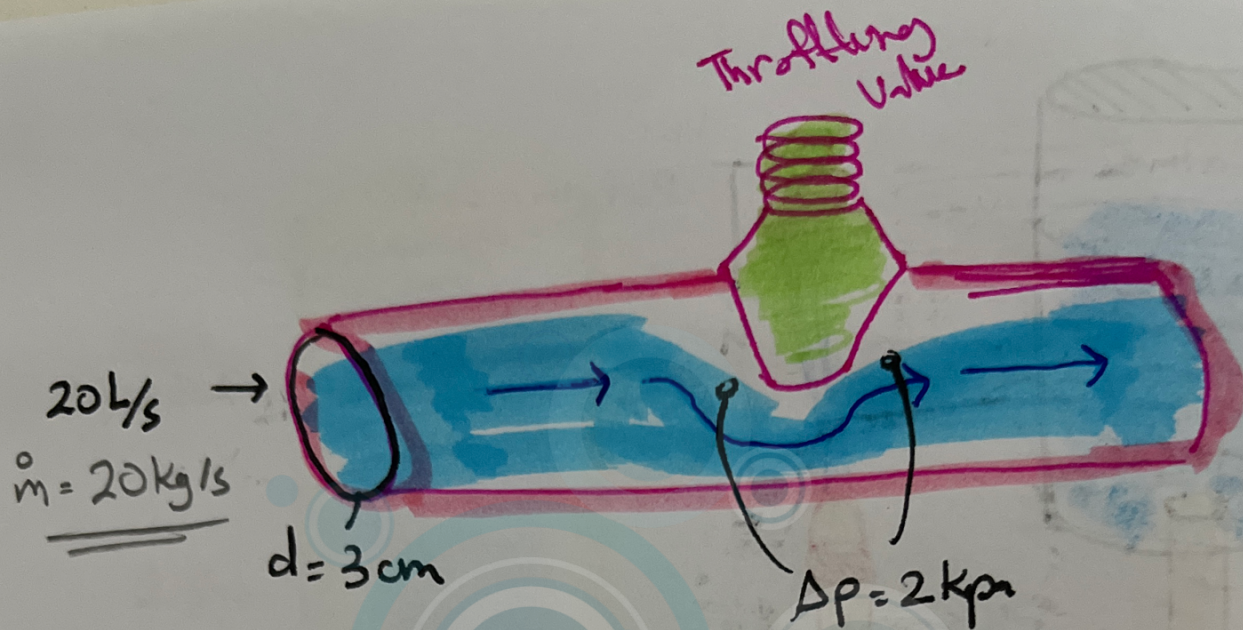


$$P_1 - P_2 = \rho \times \left(\frac{V_2^2 - V_1^2}{2} \right) = 1.2 \left(\frac{15.28^2 - 3.157^2}{2} \right)$$

$$P_1 - P_2 = 134.1 \text{ Pa}$$

$$P_1 = P_2 + 9.81(1000)(h)$$

$$\rightarrow h = 0.0137 \text{ m}$$

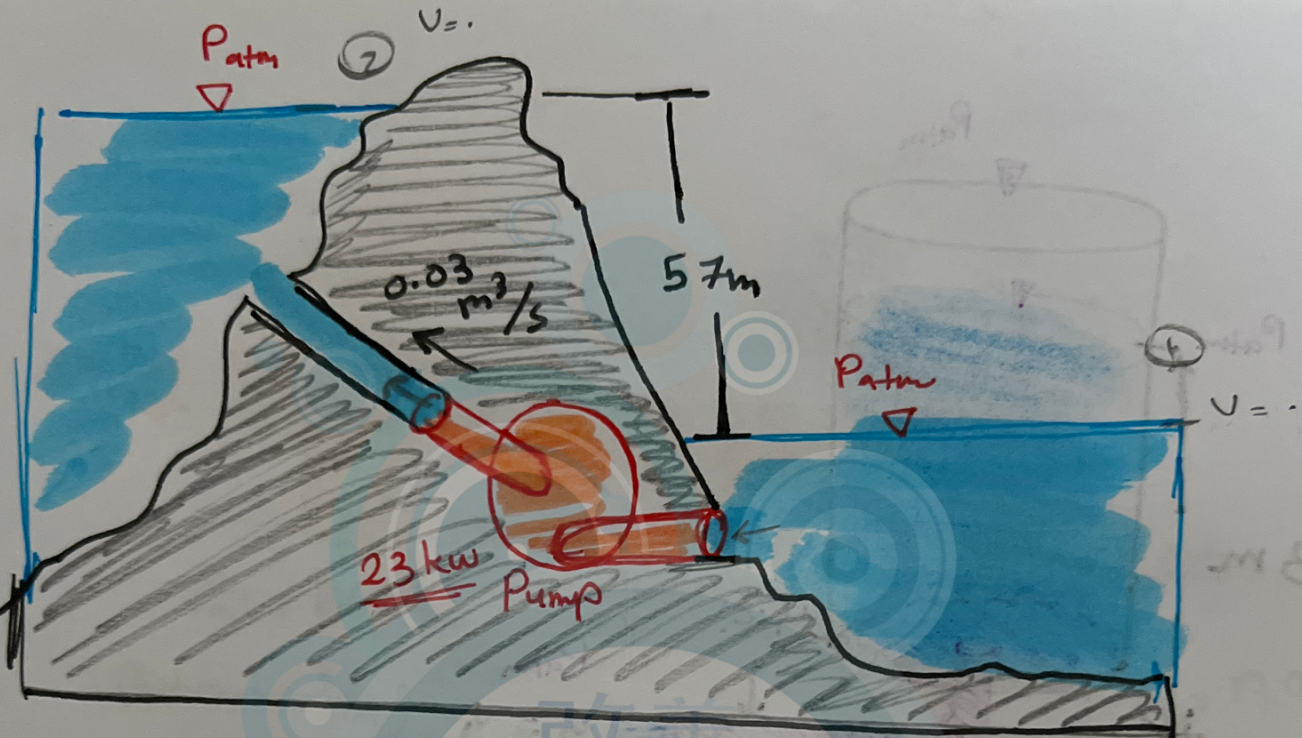


$$\frac{P_1 - P_2}{\rho g} = \frac{V_2^2 - V_1^2}{2g} + \Delta z + h_L$$

$$\rightarrow h_L = 0.204 \text{ m}$$

$$h_{\text{pump},4} = h_L = 0.204 = \frac{\dot{W}_{\text{pump},4}}{20 \times 9.81}$$

$$\rightarrow \dot{W}_{\text{pump},4} = 40 \text{ W}$$

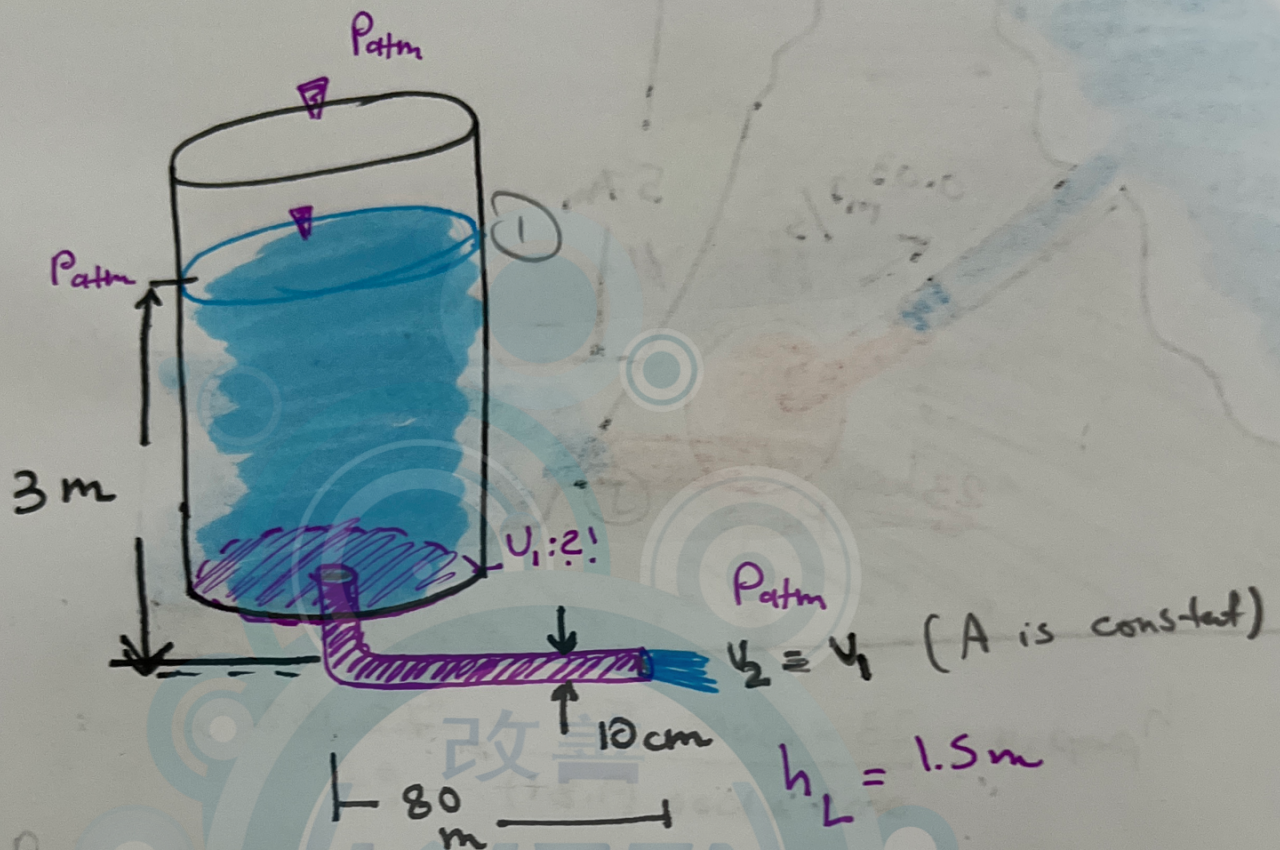


$$h_{\text{pump},v} = \frac{23 \times 1000}{0.03 \times 1000 (9.81)} = 78.152 \text{ m}$$

$$h_L = h_{\text{pump},v} + (Z_1 - Z_2) = \underline{\underline{21.15155 \text{ m}}}$$

$$h_L = \frac{\dot{W}_{\text{loss}}}{\rho \times g} = 21.15155$$

$$\rightarrow \dot{W}_{\text{loss}} = \underline{\underline{6224.9 \text{ W}}}$$



$$P_2 = 29430\text{ Pa}$$

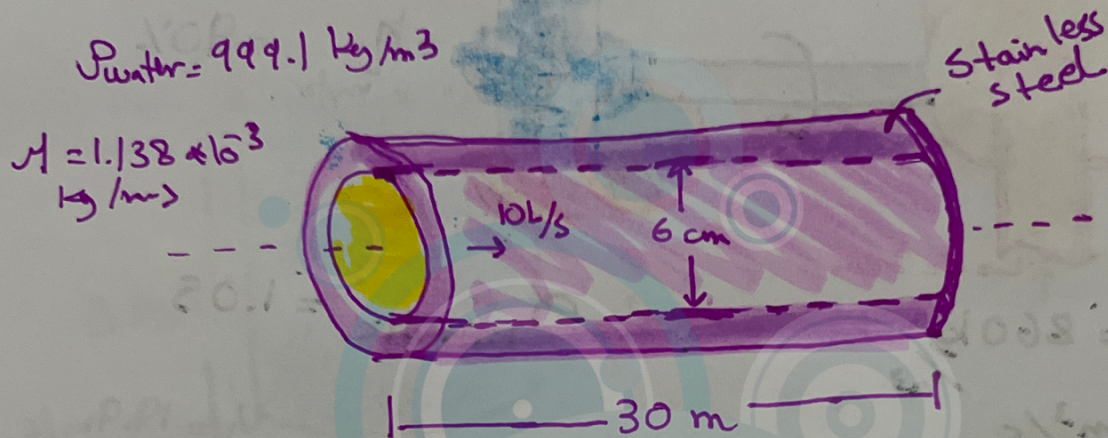
$$\frac{P_{\text{atm}}}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_L$$

where $z_1 = 3\text{ m}$, $z_2 = 1.5\text{ m}$, and $h_L = 1.5\text{ m}$.

$$3 = \frac{V_2^2}{9.81} + 1.5$$

$$\rightarrow V_2 = 5.425\text{ m/s}$$

ch14 probs



$$V_{\text{avg}} = 3.537 \text{ m/s}$$

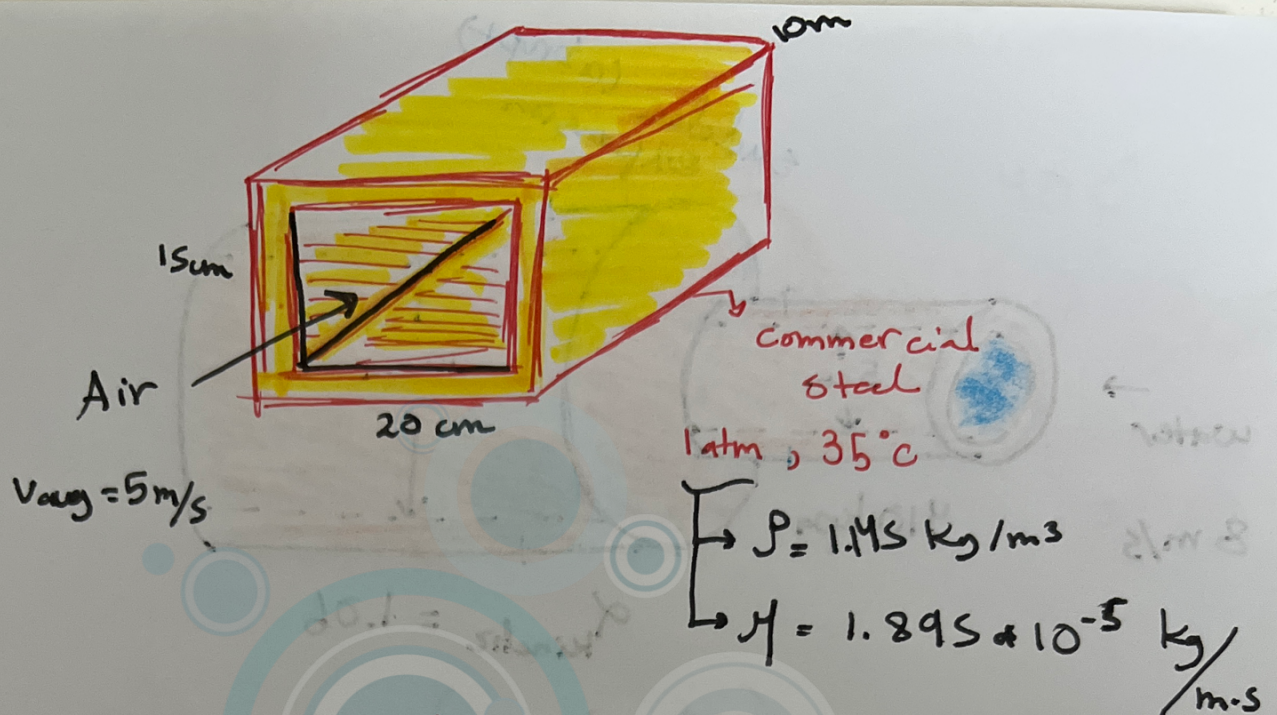
$$Re = 186305.45 > 2300 \rightarrow \text{Turbulent}$$

$$f = 0.016$$

$$\textcircled{1} \Delta p = 49.75 \text{ kPa}$$

$$\textcircled{2} h_L = 5.076 \text{ m}$$

$$\textcircled{3} W_{\text{pump}} = 497.5 \text{ W}$$



$$D_h = \frac{2(0.2 \times 0.15)}{(0.2 + 0.15)} = 0.1714 \text{ m}$$

$$Re = 51790.4 \rightarrow \text{Turbulent}$$

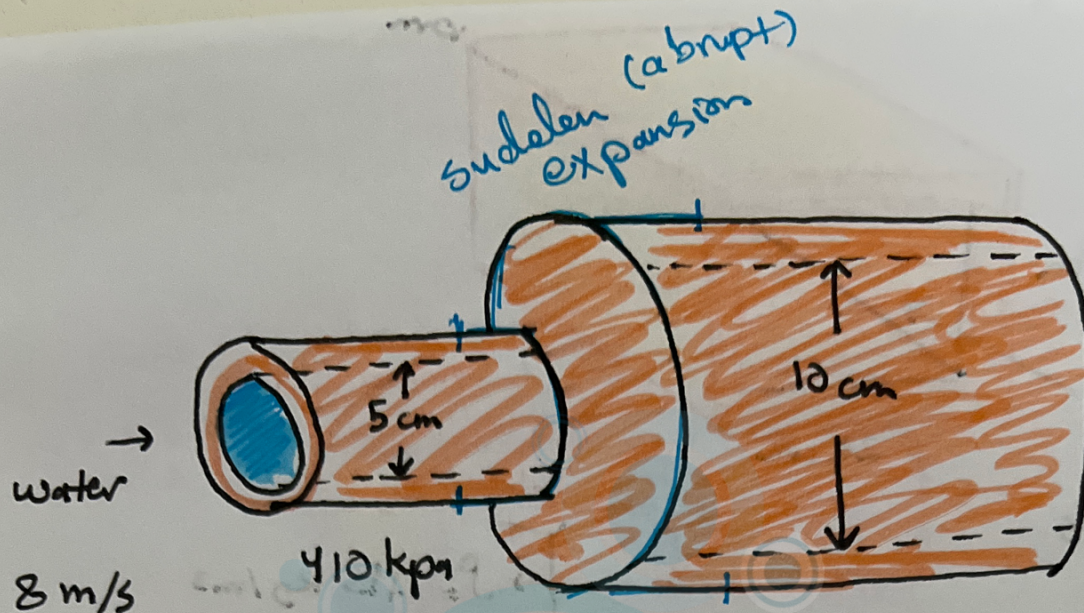
$$f = 0.0214$$

$$\Delta p = 17.8 \text{ Pa}$$

$$h_L = 1.588$$

$$\dot{W}_{loss} = 2.675 \text{ W}$$

$$\text{Fan power needed} = \dot{W}_{loss} = 2.675 \text{ W}$$



$$\alpha_{\text{kinetic}} = 1.06$$

$$V_2 = \frac{8 \times \frac{\pi}{4} (0.05)^2}{\frac{\pi}{4} (0.1)^2} = 2 \text{ m/s}$$

$$h_{L, \text{minor}} = K_L \times \frac{8^2}{2(9.81)}, K_L = 1.06 \left(1 - \frac{0.05^2}{0.1^2} \right)^2$$

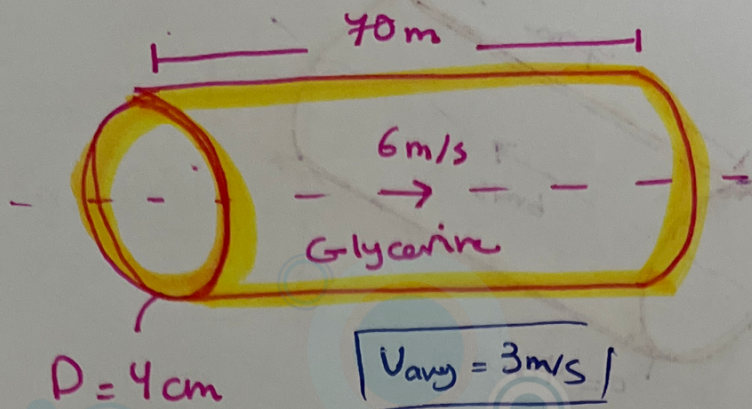
$$\boxed{K_L = 0.596}$$

$$\rightarrow h_{L, \text{minor}} = 1.945 \text{ m}$$

$$(P_1 - P_2) = 1000 (9.81) \times \left(1.06 \frac{2^2 - 8^2}{2 \times 9.81} + 1.945 \right)$$

$$410 - P_2 = 12.72$$

$$\rightarrow P_2 = 422.7 \text{ kPa}$$



40°C

$\rho = 1252 \text{ kg/m}^3$

$\mu = 0.3073 \text{ kg/m}\cdot\text{s}$

$$u(r) = 6 \times \left(1 - \frac{r^2}{(0.02)^2} \right)$$

$$u(r) = 6 - 15000 r^2$$

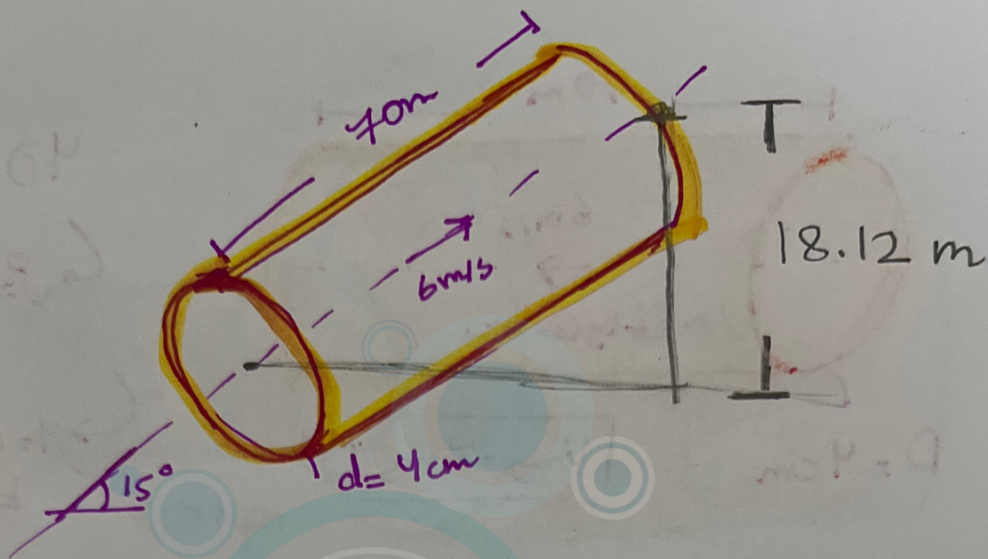
$Re = 488.9 < 2300 \rightarrow \text{laminar}$

$$f = 0.131$$

$$h_L = 105.08 \text{ m}$$

$$105.08 = \frac{W_{\text{pump}, u}}{(4.72)9.81}$$

$$W_{\text{pump}, u} = 4.866 \text{ kW}$$



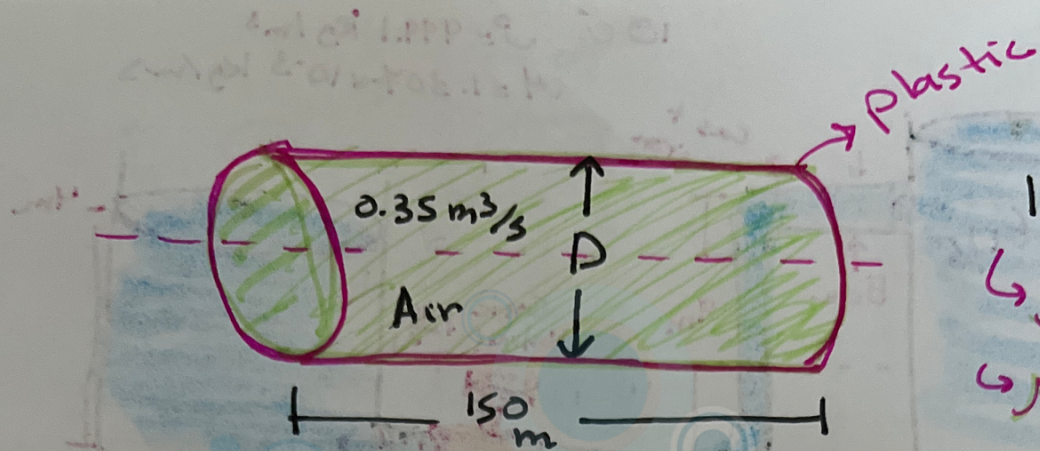
$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{V_2^2}{2g} + \frac{P_2}{\rho g} + z_2 + h_L$$

$$\Delta P = 1252 \cdot 9.81 \left(\underset{18.12}{\Delta z} + \underset{105.08}{h_L} \right)$$

$$\Delta P = 1513.2 \text{ kPa} \rightarrow \text{upward}$$

$$\Delta P = 1068.05 \text{ kPa} \rightarrow \text{downward}$$

$$V_{\text{upward}} = \frac{4.866}{1513.2} = 3.216 \cdot 10^{-3} \text{ m}^3/\text{s}$$



1 atm, 35°C

$$\rho = 1.145\text{ kg/m}^3$$

$$\mu = 1.895\text{ kg/m}\cdot\text{s} \times 10^{-5}$$

$$3 = \text{zero}$$

$$h_L = 20\text{ m}$$

$$0.35 = \frac{\pi}{4} D^2 \cdot V$$

$$V = \frac{0.4456}{D^2} \quad (1)$$

$$h_L = f \frac{(150)}{D} \frac{V^2}{2(9.81)} = 20$$

$$Re = \frac{1.145 \cdot V \cdot D}{1.895 \times 10^{-5}}$$

$$f = 13.1749 D^5 \quad (3)$$

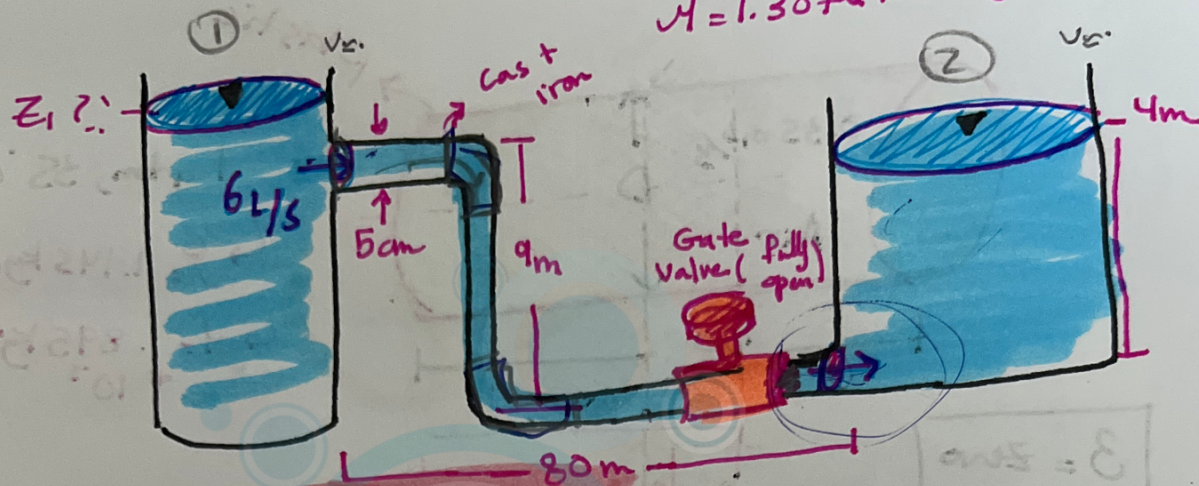
$$Re = \frac{26924.1}{D} \quad (2)$$

$$\frac{1}{\sqrt{f}} = -1.8 \log \left(\frac{6.9 D}{26924.1} \right)$$

$$\frac{1}{\sqrt{13.1749 D^5}} = -1.8 \log \left(\frac{6.9 D}{26924.1} \right)$$

$$\rightarrow D = 0.267\text{ m}$$

10°C $\rho = 999.1 \text{ kg/m}^3$
 $\mu = 1.307 \times 10^{-3} \text{ kg/m}\cdot\text{s}$



$V_{avg} = 3.056 \text{ m/s}$

$Re = \frac{3.056 \times 0.05 \times 999.1}{1.307 \times 10^{-3}} = 116795.13$
 turbulent

$f = 0.0315$

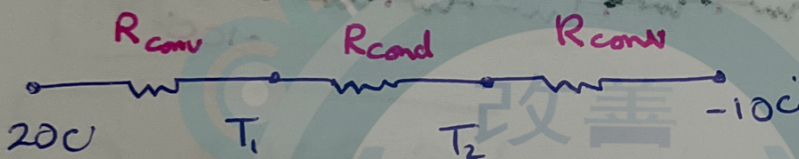
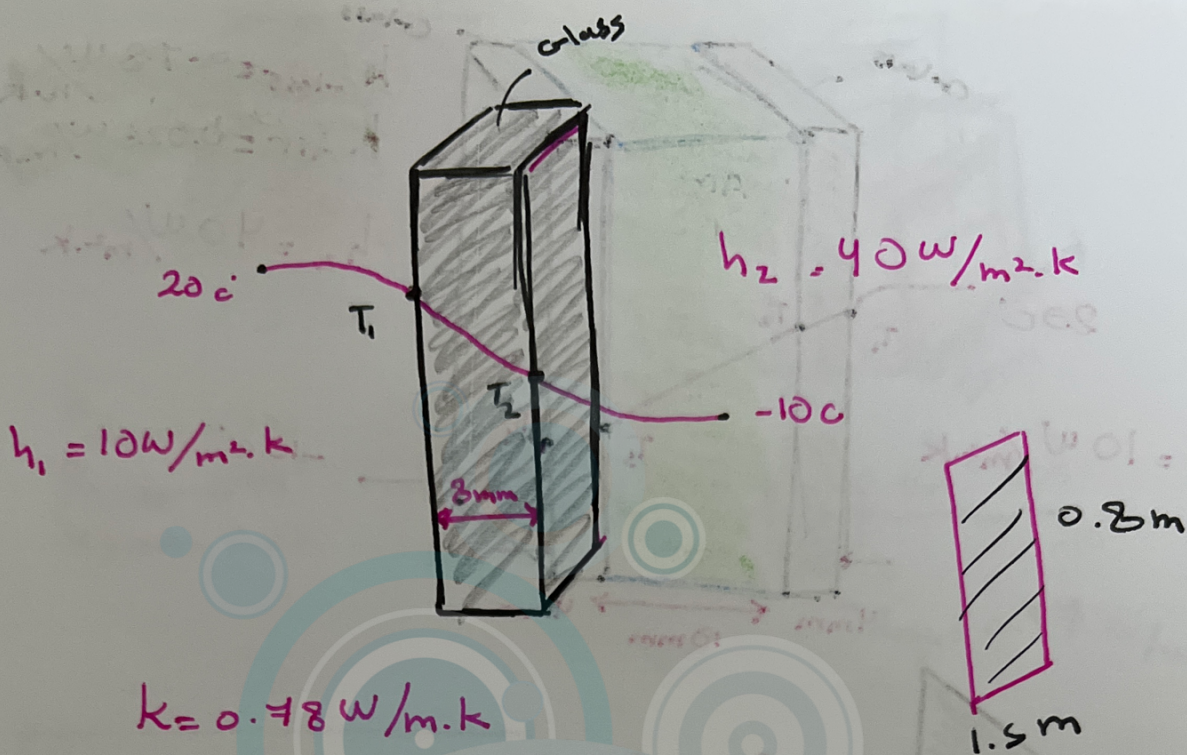
$h_L = 26.69 \text{ m}$ major

$h_{L, \text{minor}} = (0.5 + 0.3 + 0.3 + 0.2 + 1.06) \times \frac{3.056^2}{2 \times 9.81}$

$h_{L, \text{minor}} = 1.028 \text{ m}$

$z_1 = 4 + (26.69 + 1.028)$

$z_1 = \underline{\underline{31.7 \text{ m}}}$

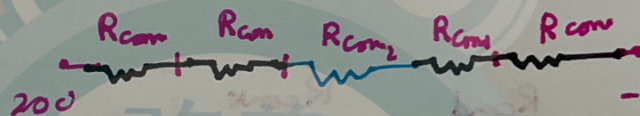
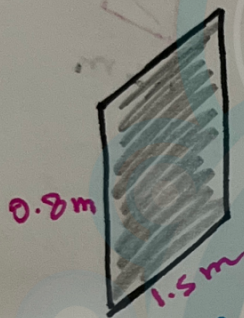
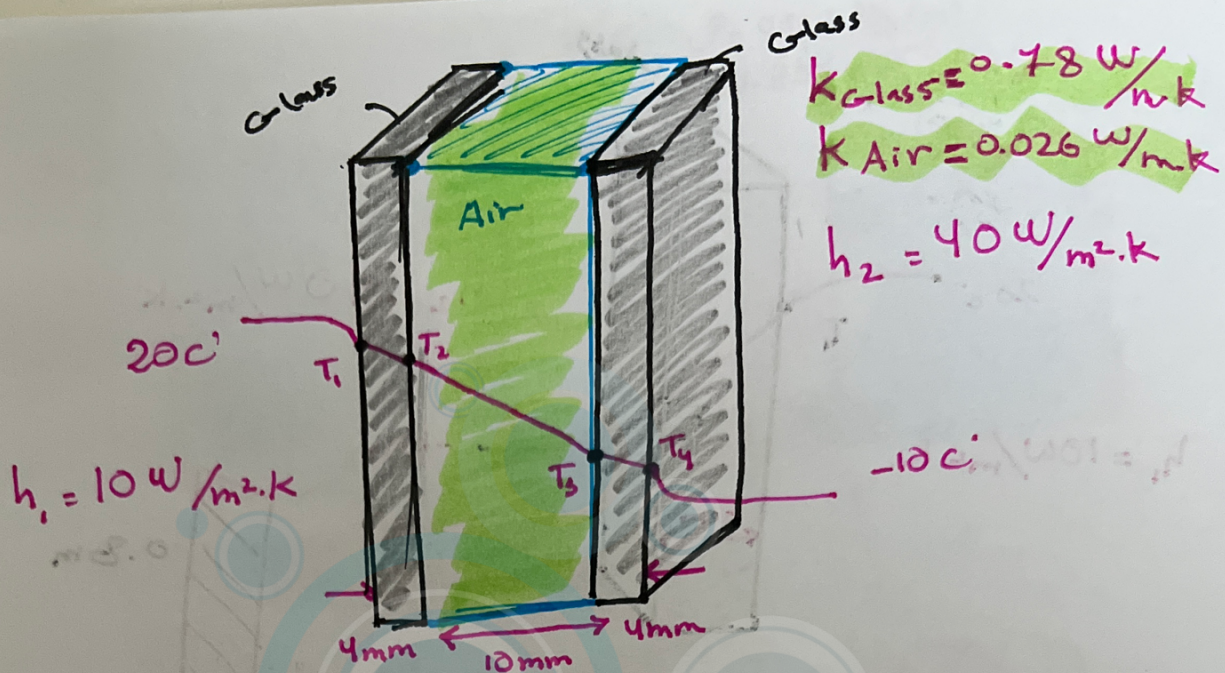


$$R_{\text{eq}} = 0.1127 \text{ } ^\circ\text{C/W}$$

$$Q = \frac{(20 - (-10))}{0.1127} = 266.16 \text{ W} \quad \text{--- ①}$$

$$266.16 = \frac{20 - T_1}{1/12} \rightarrow T_1 = -2.18^\circ\text{C}$$

$$266.16 = \frac{T_2 + 10}{1/48} \rightarrow T_2 = -4.455^\circ\text{C}$$

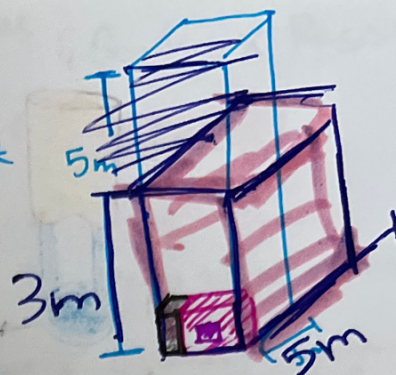
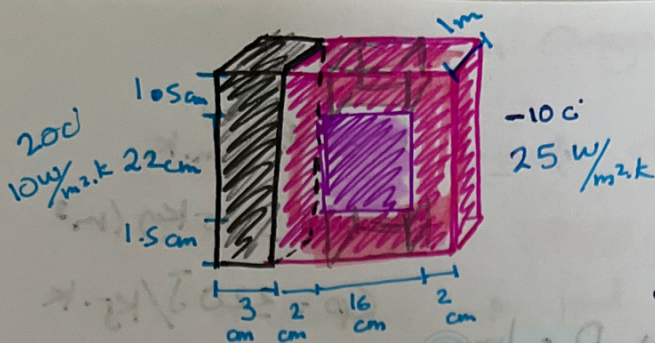


$$R_{\text{eq}} = 0.433 \text{ }^\circ\text{C/W}$$

$$\dot{Q} = 69.25 \text{ W}$$

$$69.25 = \frac{20 - T_1}{1/12} \rightarrow T_1 = \cancel{14.23} \text{ }^\circ\text{C}$$

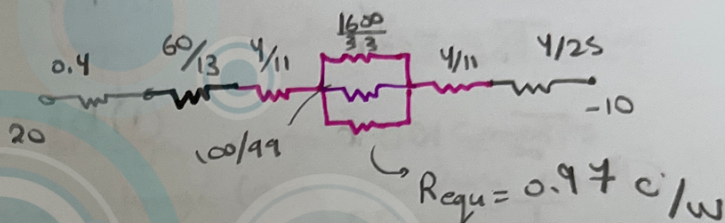
$$69.25 = \frac{T_4 - (-10)}{1/48} \rightarrow T_2 = -8.56 \text{ }^\circ\text{C}$$



$$k_{\text{form}} = 0.026$$

$$k_{\text{bricks}} = 0.72$$

$$k_{\text{plaster}} = 0.22$$



$$R_{\text{eq}} = 6.87 \text{ } ^\circ\text{C/W}$$

$$Q = 4.365 \text{ W}$$

$$Q_{\text{Total}} = \left(\frac{15}{0.25} \right) \times 4.365 = \underline{\underline{261.92 \text{ W}}}$$

or :-

$$Q_{\text{per unit of area}} = \frac{4.365}{0.25} = \underline{\underline{17.46 \text{ W/m}^2}}$$

$$Q_{\text{Total}} = 15 \times 17.46 = 261.9 \text{ W}$$



$D = 1 \text{ mm}$
Sphere

$$k = 35 \text{ W/m}\cdot\text{K}$$

$$\rho = 8500 \text{ kg/m}^3$$

$$C_p = 320 \text{ J/kg}\cdot\text{K}$$

$$h = 210 \text{ W/m}^2\cdot\text{K}$$

$$T_i = \text{zero}$$

$$T_\infty = 100^\circ\text{C}$$

$$T(t) = 99$$

$$\textcircled{1} Bi = \frac{210 \times L_c}{35}$$

$$L_c = \frac{\pi}{6} (0.001)^3$$

$$\pi (0.001)^2$$

$$Bi = 0.001 \leq 0.1$$

✓ Lumped

$$b = \frac{210}{8500 (L_c) 320}$$

$$b = 0.4632$$

$$-0.4632 (t)$$

$$\frac{99 - 100}{-100} = e$$

$$t = 9.94 \text{ s}$$

$$t \approx 10 \text{ s}$$