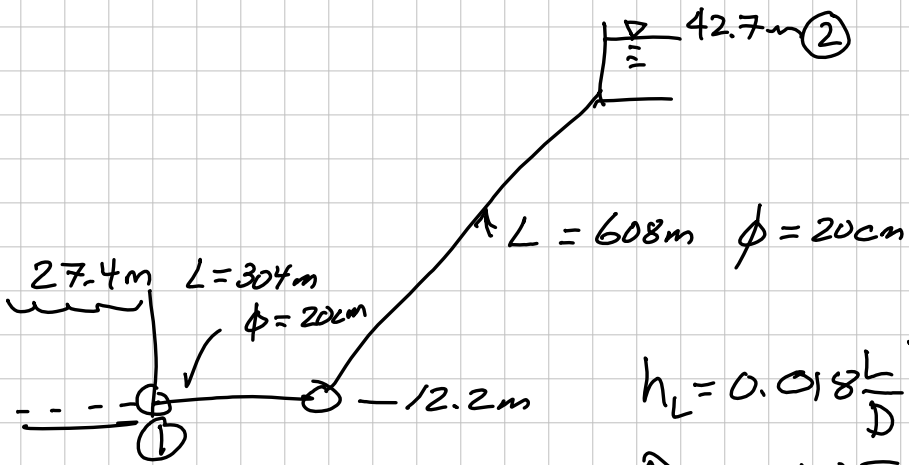


# SKETCH



## KNOWN

POOL ELEV. ; PIPE LENGTHS ;  $Q$   
DIAMETERS ; HEAD LOSS ;

## UNKNOWN

PUMP HEAD

## GEN. EQN

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

↑  $27.4 - 12.2$       ↑  $12.2m$       ~~NO TURBINES~~  
TOTAL HEAD @ (2)  
= 42.7

## SOLUTION

$$\frac{p_1}{\gamma} + \frac{v_1^2}{2g} + z_1 + h_p = \frac{p_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_L$$

27.4 - 12.2      12.2m      TOTAL HEAD @ (2)  
= 42.7

## SUBSTITUTIONS

$$15.2\text{m} + \frac{v^2}{2g} + h_p = 42.7 + h_L$$

$$v = \frac{0.085\text{m}^3/\text{s}}{\frac{\pi (0.20\text{m})^2}{4}} = 2.705\text{m/s}$$

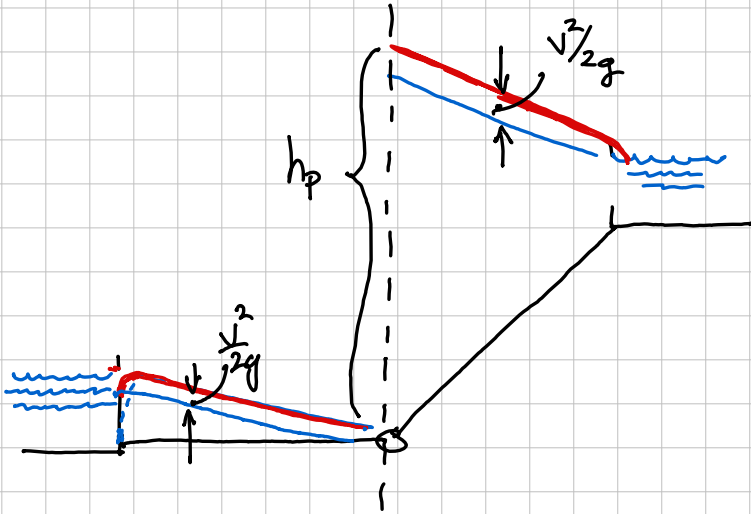
$$h_p = 42.7 - 15.2 - \frac{v^2}{2g} + h_L$$

$$= 27.1 + 0.018 \frac{(304 + 608)(2.705)^2}{(0.20)(2)(9.8)}$$

$$= 57.7\text{m}$$

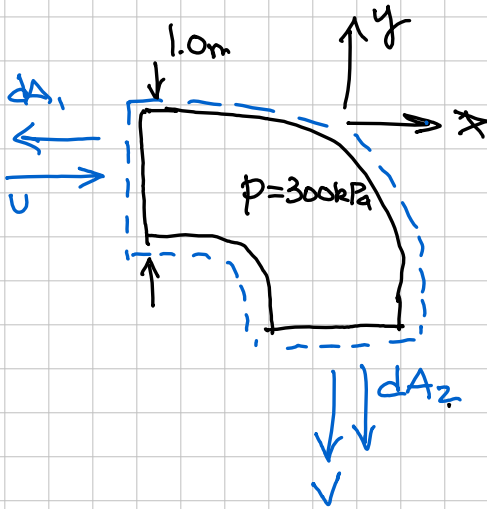
## DISCUSSION

ENERGY EQUATION APPLICATION. USE TOTAL HEADS TO REDUCE WORKLOAD



EGL (red); HGL (blue)

## PROBLEM 2



90° F ELBOW

KNOWN

$$Q = 10 \text{ m}^3/\text{s}$$

UNKNOWN

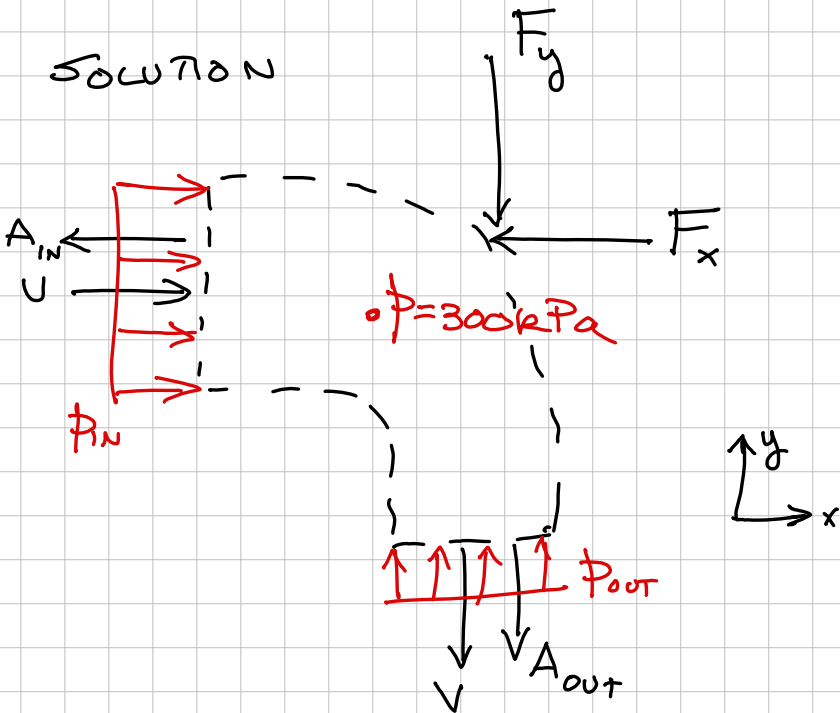
RESTRAINING FORCES

GOV. EQN

CONTINUITY

MOMENTUM

SOLUTION



MOMENTUM

Non DEFORMING CV

$$\sum F_x = \frac{d}{dt} \int_{CV} \rho U \, dV + \int_{C.S.} \rho U (U \cdot dA)$$

$$p_{IN} A_{IN} - F_x = -\rho U_{IN} A_{IN}$$

NOTE:  $V, A_{OUT}, p_{OUT}$  ARE IN  $+y$  AXIS

$$F_x = \rho U_{IN} A_{IN} + p_{IN} A_{IN}$$

$$F_x = \left(\frac{10 \text{ m}^3}{\text{s}}\right) \left(1000 \frac{\text{kg}}{\text{m}^3}\right) + 300 \cdot 10^3 \frac{\text{N}}{\text{m}^2} \frac{\pi \text{ m}^2}{4}$$

$$F_x = 245619.4 \text{ N}$$