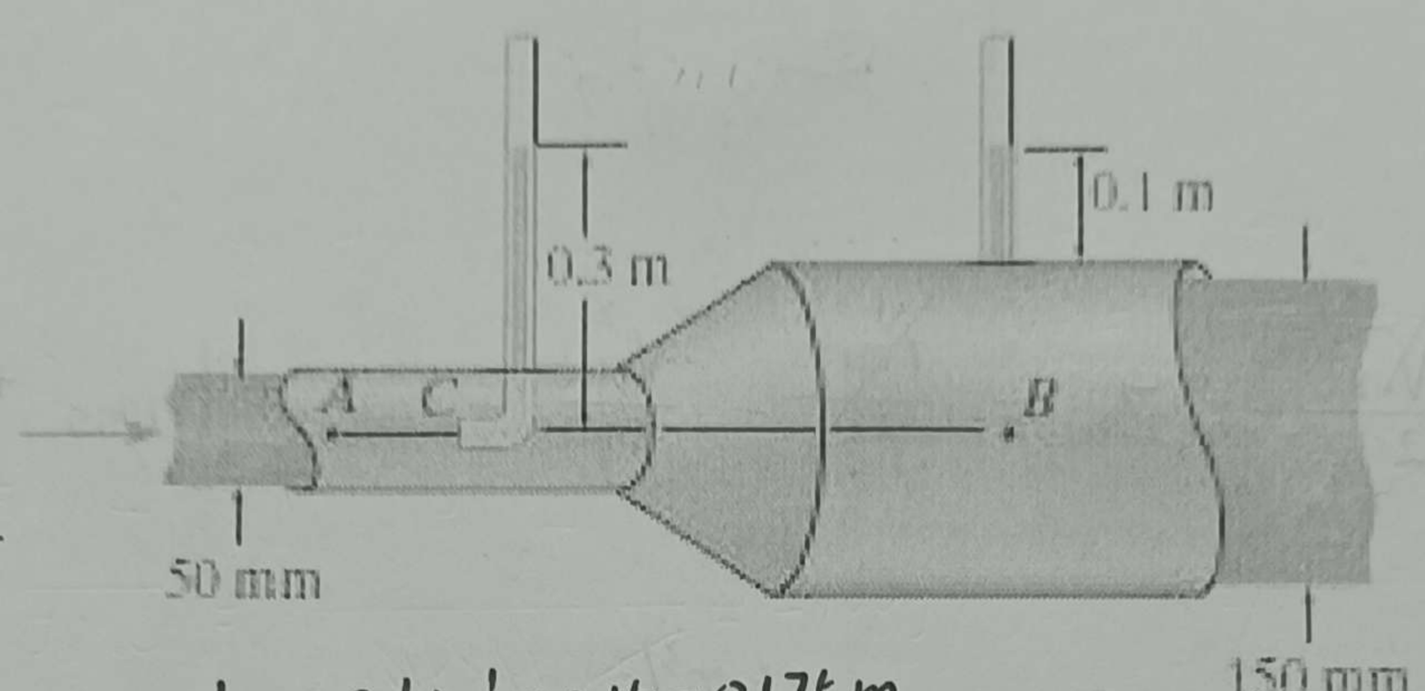
Homework 5

Questions No.	1	2	3	Total
Score	30%	40%	30%	100%

Q5.1 Determine the volumetric flow and the pressure in the pipe at A if the height of the water column in the Pitot tube is $0.3\ m$ and the height in the piezometer is $0.1m$.



解:

$\frac{P}{\rho}+\frac{1}{2}v^2+gz=Const$

set reference z : ABC .

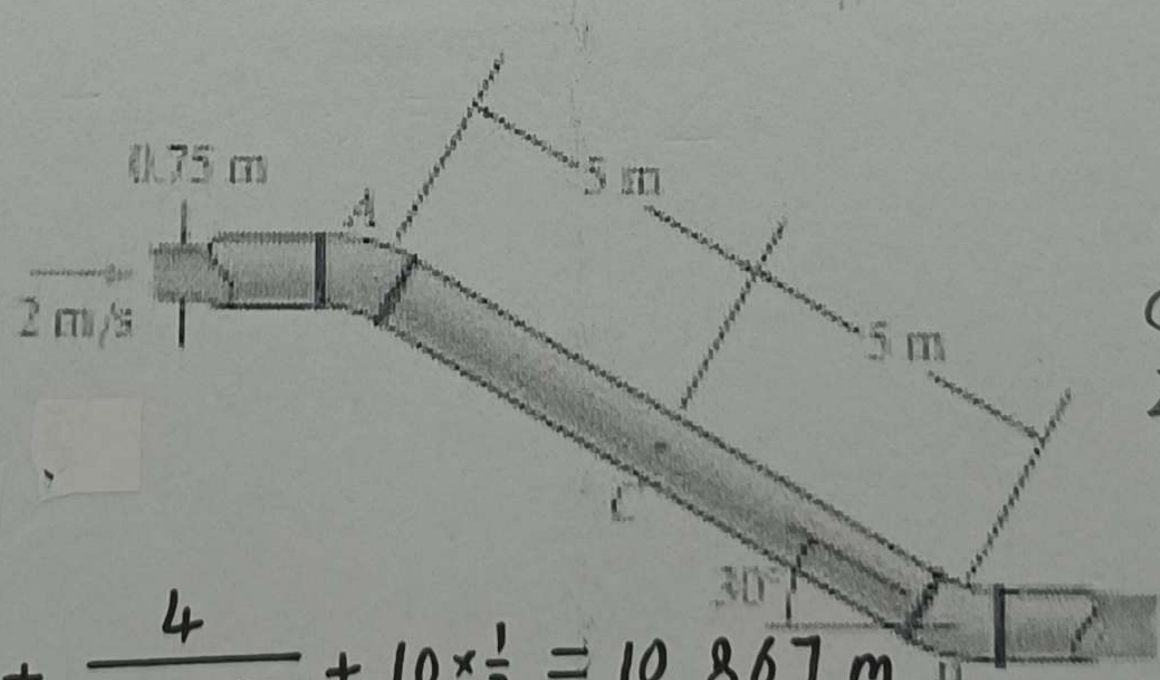
$\frac{P_A}{\rho}+\frac{1}{2}V_A^2=\frac{P_C}{\rho}+0=\frac{P_B}{\rho}+\frac{1}{2}V_B^2$

$P_C=\rho g h_C$, $P_B=\rho g h_B$, $h_C=0.3m$, $h_B=0.1+\frac{1}{2}\times 0.15=0.175m$

$V_A\cdot\pi(\frac{d_A}{2})^2=V_B\cdot\pi(\frac{d_B}{2})^2$

Solve and get: $P_A=-96.32kPa$, $V_A=14.09\ m/s$, $V_B=1.566\ m/s$, volumetric $flow_A=\pi\cdot(\frac{d_A}{2})^2\cdot V_A=2.767\times10^{-2}\ m^3/s$

Q5.2 Oil flows through the constant-diameter pipe such that at A the pressure is $50\ kPa$, and the velocity is $2m/s$. Plot the pressure head and the gravitational head for AB using a datum at B. Take $\rho_0=900kg/m^3$. Assume oil flow is compressible which is a reasonable assumption.



Since constant-diameter

$V_{AB}\cdot A_{AB}=V_A\cdot A_{AB}$

$V_{AB}=V_A=2m/s$.

$\therefore \frac{P_{AB}}{\rho_0 g}+Z_{AB}=10.867-\frac{4}{2\times9.81}=10.66m$

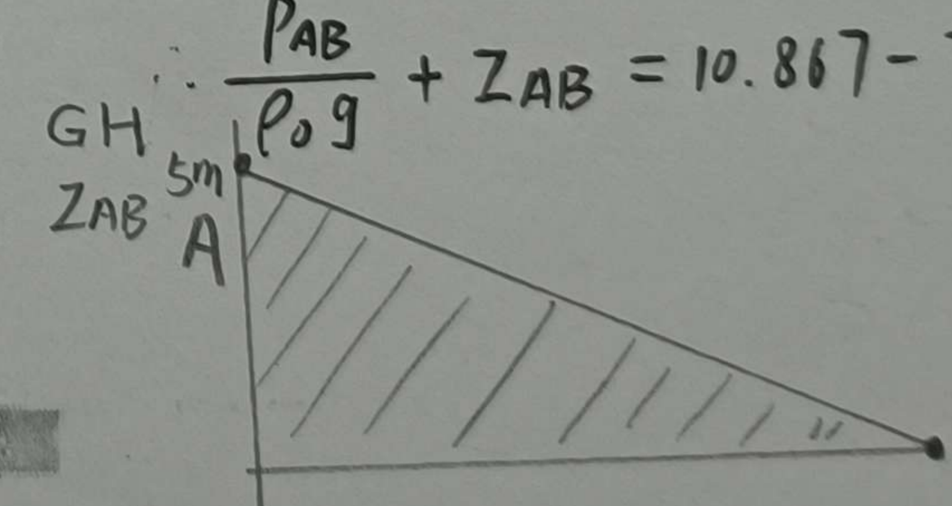
解: $\frac{P}{\rho}+\frac{1}{2}v^2+gz=Const$

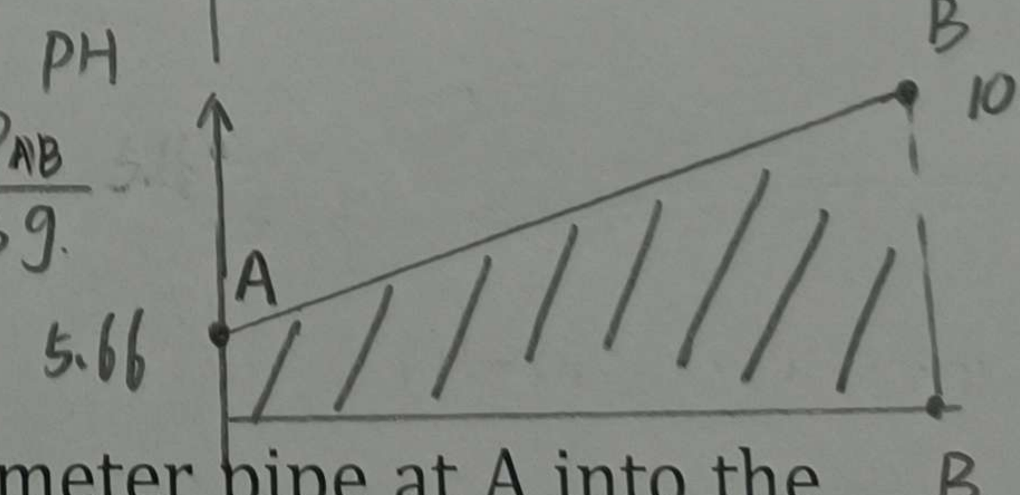
$\frac{P}{\rho g}+\frac{v^2}{2g}+z=Const.$

Point A: $\frac{P_A}{\rho_0 g}+\frac{V_A^2}{2g}+Z_A=Const$

$=\frac{50\times10^3}{900\times9.81}+\frac{4}{2\times9.81}+10\times\frac{1}{2}=10.867\ m$

for AB: $\underbrace{\frac{P_{AB}}{\rho_0 g}}_{PH}+\frac{V_{AB}^2}{2g}+\underbrace{Z_{AB}}_{GH}=10.867\ m$



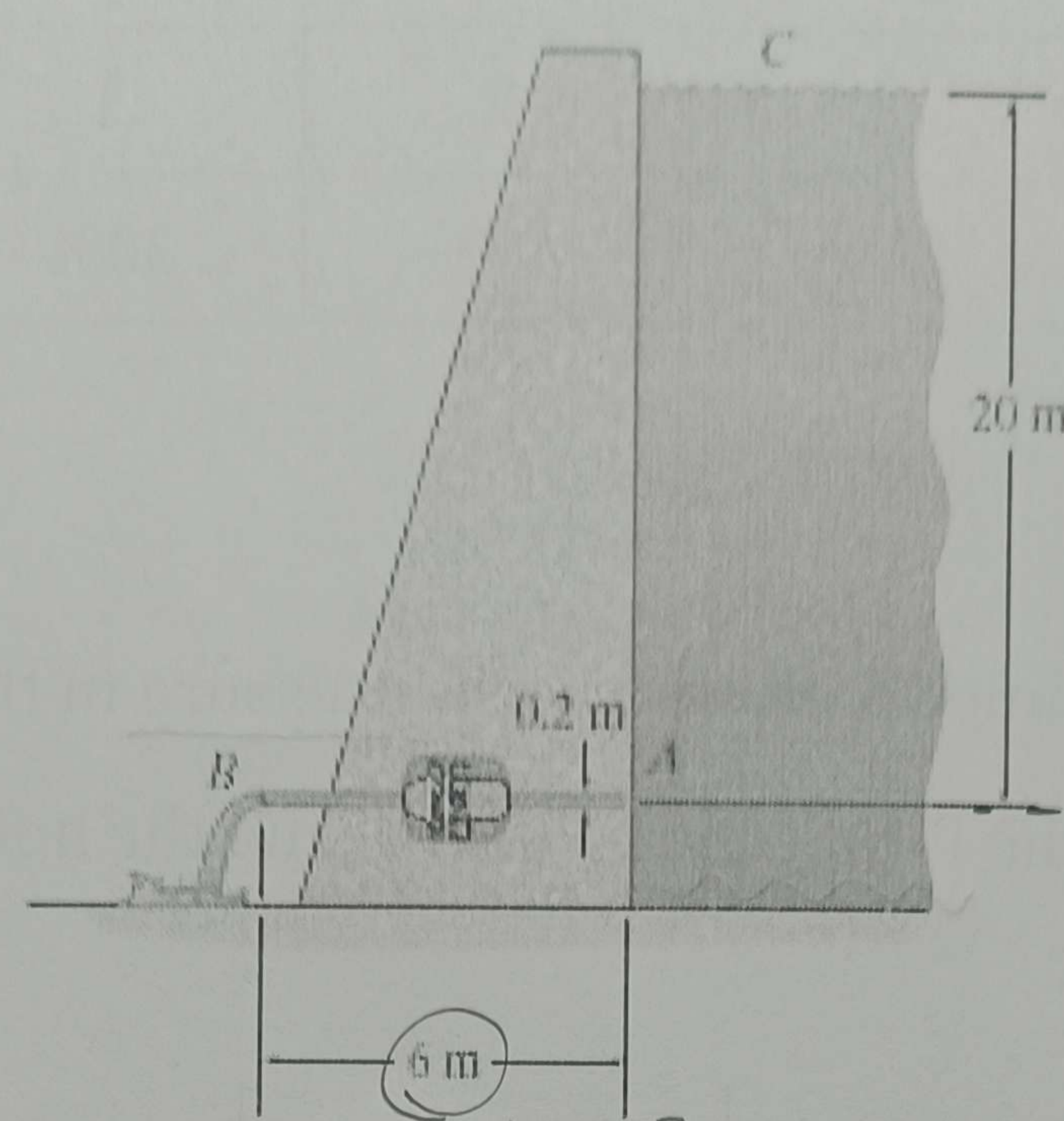


Q5.3 Water in the reservoir flows through the 0.2-m-diameter pipe at A into the turbine. If the discharge at B is $(0.5m^3/s)$ determine the power output of the turbine. Assume the turbine runs with an efficiency of 65%, and there is a head

$\eta=65\%$.

$\eta=\frac{h_{turbine.actural}}{h_{turbine.ideal}}$

loss of 0.5m through the pipe.



- - - reference level.

何用?

DDL:2021/05/09

解: $\cancel{\frac{P_{in}}{\rho g}} + \cancel{\frac{V_{in}^2}{2g}} + Z_{in} = \cancel{\frac{P_{out}}{\rho g}} + \frac{V_{out}^2}{2g} + Z_{out} + h_{loss} + h_{turbine.ideal}$.

$P_{in} = P_{out}$

$V_{in} = 0$, $V_{out} = \frac{Q_{out}}{A_{out}} = \frac{0.5\,m^3/s}{\pi \times 0.1^2} = 15.92\,m/s$

$Z_{in} = 20m$, $Z_{out} = 0m$.

$h_{loss} = 0.5m$

$\Rightarrow h_{\substack{turbine.\\ideal}} = -\left(\frac{15.92^2}{2 \times 9.81} + 0 + 0.5 - 20\right) = +6.582\,m$

$P_{turbine.out} = \eta \cdot \dot{m} g \cdot h_{\substack{turbine.\\ideal}} = 65\% \times \rho \times 0.5 \times 9.81 \times 6.582 = 20.99\,kW$