PART A Examples Assignment 5

Prob. 4.1

Data:

$S = 1.26$

$\gamma_{liq} = 12360.6 \ N/m^3$

$Q = 700 \ L/s \quad \because 1 L = 10^{-3} m^3$

$= 700 \times 10^{-3} \ m^3/s$

$d_1 = 60 \ cm = 0.6 m$

$P_1 = 300 \ kN/m^2$

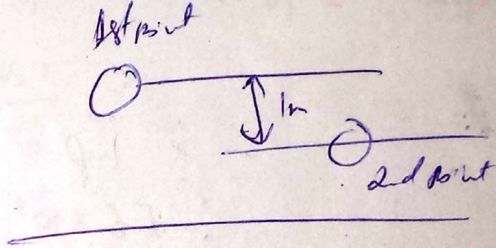
$= 300 \times 10^3 \ N/m^2$

$P_2 = ?$

$d_2 = 30 \ cm = 0.3 m$

Point 2 is 0.1m lower than first point.

h_L = Neglected



Sol:

$Q = AV$

$V_1 = \dfrac{Q}{A_1}$

$= \dfrac{700 \times 10^{-3}}{\frac{\pi (0.6)^2}{4}} = 2.47 m/s$

$V_2 = \dfrac{Q_1}{A_2}$

$= \dfrac{700 \times 10^{-3}}{\frac{\pi (0.3)^2}{4}} = 9.90 m/s$

Using Bernoulli's equation

$$Z_1 + \frac{P_1}{\gamma_1} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma_2} + \frac{V_2^2}{2g}$$

$$1 + \frac{300 \times 10^3}{12360.6} + \frac{2.47^2}{2 \times 9.81} = 0 + \frac{P_2}{12360.6} + \frac{9.90^2}{2 \times 9.81}$$

$$\boxed{P_2 = 254.45 \ kN/m^2}$$

Prob 4.3

Data

Pumping

$S = 1.26 \Rightarrow \gamma = 12360.6\, N/m^3$

'A'

$d_1 = 60\, cm = 0.6 m$

$P_1 = 300\, kN/m^2 = 300 \times 10^3\, N/m^2$

At 'B'

$d_2 = 30\, cm = 0.3 m$

$P_2 = 330\, kN/m^2 = 330 \times 10^3\, N/m^2$

Point B is 1m lower than A

$Q = ?$

$h_L =$ Neglected

Input $= 16 KW$

$Q = AV$

$V_1 = \dfrac{Q}{\frac{\pi (0.6)^2}{4}}$ $\qquad V_2 = \dfrac{Q}{\frac{\pi (0.3)^2}{4}}$

$V_1 = \dfrac{Q_1}{0.282}$ $\qquad V_2 = \dfrac{Q_2}{0.070}$

Sol:

$$P = \gamma Q h$$

$$16 \times 10^3 = \gamma Q h_p$$

$$16 \times 10^3 = 12360.6 \times Q\, h_p$$

$$h_p = \frac{1.29}{Q}$$

As

$$Z_1 + \frac{P_1}{\gamma_1} + \frac{V_1^2}{2g} + h_p = Z_2 + \frac{P_2}{\gamma_2} + \frac{V_2^2}{2g}$$

$$1 + \frac{300 \times 10^3}{12360.6} + \frac{[Q/0.282]^2}{2 \times 9.81} + \frac{1.29}{Q} = 0 + \frac{330 \times 10^3}{12360.6} + \frac{(Q/0.070}{2 \times 9.81}$$

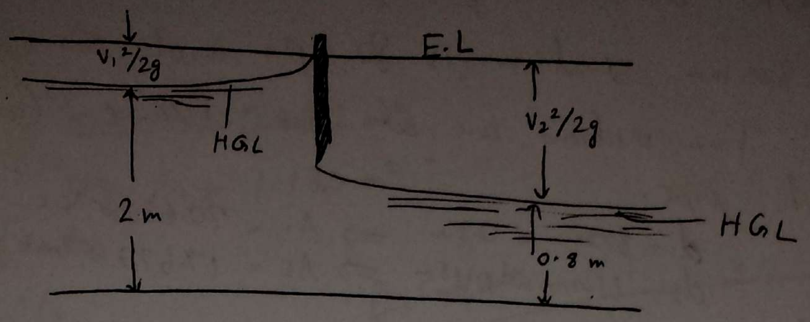
$$\boxed{Q = 0.42\, m^3/s}$$

Prob 4.8

Data:

h_L = Neglected

$Q = ?$



Sol:

Energy equation

$$2 + \frac{V_1^2}{2g} = 0.8 + \frac{V_2^2}{2g}$$

$$2 + \frac{V_1^2}{2\times 9.81} = 0.8 + \frac{V_2^2}{2\times 9.81}$$

$$V_2^2 - V_1^2 = 23.544 \quad \text{—— (1)}$$

The energy line is a distance $\frac{V^2}{2g}$ above the water surface

Assuming $\alpha = 1$

From continuity

$$(2\times 1)V_1 = (0.8\times 1)V_2 \quad \text{—— (2)}$$

$$V_1 = 0.4V_2 \quad \text{—— (3)}$$

Putting (3) in (1)

$$V_2^2 - (0.4V_2)^2 = 23.544$$

$$V_2^2 - 0.16V_2^2 = 23.544$$

$$0.84V_2^2 = 23.544$$

$$V_2^2 = 28.02$$

$$\boxed{V_2 = 5.29\ m/s}$$

$\Rightarrow V_1 = 0.4 \times 5.29$

$$\boxed{V_1 = 2.11\ m/s}$$

$$\frac{V_1^2}{2g} = \frac{2.11^2}{2\times 9.81} = 0.227$$

$$\frac{V_2^2}{2g} = \frac{5.29^2}{2\times 9.81} = 1.42m$$

$\Rightarrow Q = (2\times 1)V_1$

$= 2(2.11)$

$$\boxed{Q = 4.23\ m^3/s}$$

or $Q = 0.8V_2$

$= 0.8(5.29)$

$$\boxed{Q = 4.23\ m^3/s}$$

An oil of unit weight 8KN/m3 is flowing upward through a vertical pipe line which tapers from 300mm → 150mm. Pressure at 300mm section is 80 kPa and 150 mm section is 48 KPa. Two sections are at 1m distance. Calculate flow rate through pipe.

Sol:

$d_1 = 300mm = 0.3m \Rightarrow A_1 = 70.68 \times 10^{-3} m^2$

$d_2 = 150mm = 0.15m \Rightarrow A_2 = 17.67 \times 10^{-3} m^2$

$\gamma = 8KN/m^3$

$Q = ?$

As

$Q = AV$

Velocity of flow is unknown, which will be computed by applying Bernoulli's equation b/w section ① and section ②

$$Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$$

$$0 + \frac{80}{8} + \frac{V_1^2}{2g} = 1 + \frac{48}{8} + \frac{V_2^2}{2g} \quad \text{— ①}$$

Also as:

By equation of continuity

$A_1V_1 = A_2V_2$

$$V_2 = \frac{A_1V_1}{A_2} = \frac{(70.68 \times 10^{-3})(V_1)}{17.67 \times 10^{-3}} = 4V_1$$

From ①

$$\frac{80}{8} + \frac{V_1^2}{2g} = 1 + \frac{48}{8} + \frac{4V_1}{2g}$$

$V_1 = 1.98 m/s$

$Q_1 = A_1V_1$

$= 70.68 \times 1.98 = \cancel{0.0.47}$

0.1399

$= 0.14 \ m^3/s$

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PART-B

Prob 4.5

Data:

Frictionless flow

$d_1 = 0.6m \Rightarrow A_1 = 0.282 \ m^2$

$d_2 = 1.2m \Rightarrow A_2 = 1.130 \ m^2$

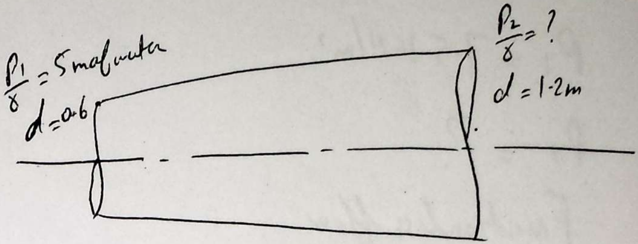
$h_1 = 5m$ of water

$Q = 3.5 m^3/s$

$V_1 = ?$

$V_2 = ?$

$h_2 = ?$



Sol:

$Q = A_1 V_1$

$V_1 = \frac{Q}{A_1}$

$= \frac{3.5}{0.282}$

$\boxed{V_1 = 12.41 \ m/s}$

$V_2 = \frac{Q}{A_2}$

$= \frac{3.5}{1.130}$

$\boxed{V_2 = 3.097 \ m/s}$

Applying Bernoulli's equation

$$Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$$

$$5 + \frac{12.41^2}{2 \times 9.81} = \frac{P_2}{\gamma} + \frac{3.097^2}{2 \times 9.81}$$

$Z_1 = Z_2$

Since datum is horizontal li

$$\boxed{\frac{P_2}{\gamma} = 12.36 \ m \text{ of water}}$$

Prob 4.6

Data:

$Q = 4\, m^3/s$

$d_1 = 1\,m \Rightarrow A_1 = 0.785\, m^2$

$d_2 = 1.5\, m \Rightarrow A_2 = 1.767\, m^2$

$P_1 = 7.5\, KN/m^2$

$P_2 = ?$

Frictionless flow

Fluid = Water

Sol:

$$V_1 = \frac{Q}{A_1} = \frac{4}{0.785} = 5.09\, m/s \qquad V_2 = \frac{Q}{A_2} = \frac{4}{1.767} = 2.263\, m/s$$

Applying Bernoulli's equation

$$Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$$

$$\frac{7.5 \times 10^3}{9810} + \frac{(5.09)^2}{2 \times 9.81} = \frac{P_2}{9810} + \frac{2.263^2}{2 \times 9.81}$$

$$\boxed{P_2 = 17.89\, KN/m^2}$$

Prob 4.7

Data:

$d = 2m$

$l = 20m$

$h_1 = 5m$ of water

$V = 5 m/s$

$h_L = 1.25 m$

$h_2 = ?$

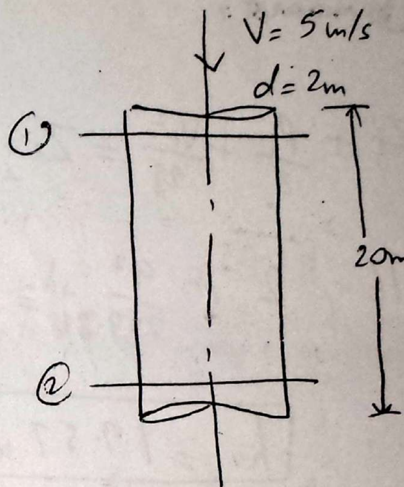
a) downward

b) upward

Sol:

a) Downward:

Applying the energy equation



Considering section 2 as datum

$$Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + h_L$$

$$20 + 5 + \frac{5^2}{2\times 9.81} = 0 + \frac{P_2}{\gamma} + \frac{5^2}{2\times 9.81} + 1.25$$

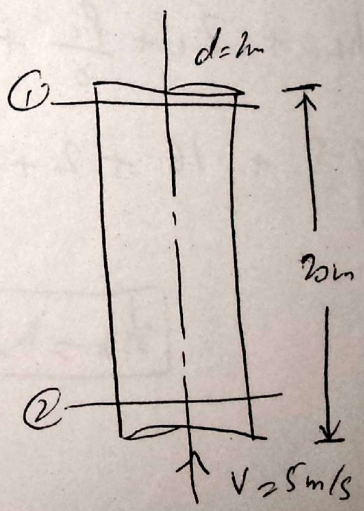
$$\boxed{\frac{P_2}{\gamma} = 23.75 \text{ m of water}}$$

b) upward:

$$h_L + Z_1 + \frac{P_1}{\gamma} + \cancel{\frac{V_1^2}{2g}} = Z_2 + \frac{P_2}{\gamma} + \cancel{\frac{V_2^2}{2g}}$$

$$1.25 + 20 + 5 = 0 + \frac{P_2}{\gamma}$$

$$\boxed{\frac{P_2}{\gamma} = 26.25 \text{ m of water}}$$



Prob 4.8

Data:

$d_1 = 0.5\,m \Rightarrow A_1 = 0.196\,m^2$

$d_2 = 1.5\,m \Rightarrow A_2 = 1.767\,m^2$

$l = 16\,m$

$h_L = 2.5\,m$

$V_1 = 9\,m/s$

$h_1 = 2\,m$ of water

$h_2 = ?$

when flow is

a) downward

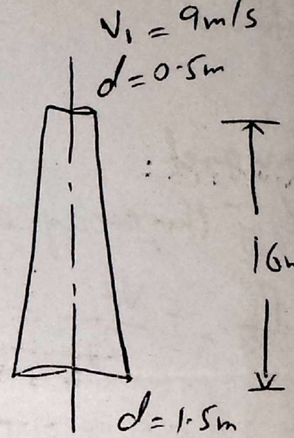
b) upward

$V_2 = \dfrac{Q}{A_2} = \dfrac{1.764}{1.767} = 0.998\,m/s$

$Q = A_1V_1 = 0.196 \times 9 = 1.764\,m^3/s$

Sol:

a) Downward:



$$Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + h_L$$

$$16 + 2 + \frac{9^2}{2\times 9.81} = 0 + h_2 + \frac{(0.998)^2}{2\times 9.81} + 2.5$$

$$\boxed{h_2 = 19.57\ m\ \text{of water}}$$

b) Upward:

$$h_L + Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$$

$$2.5 + 16 + 2 + \frac{9^2}{2\times 9.81} = 0 + h_2 + \frac{0.998^2}{2\times 9.81}$$

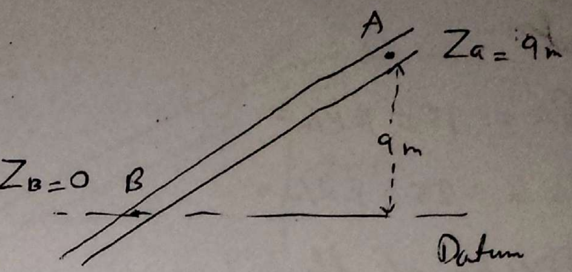
$$\boxed{h_2 = 24.577\ m\ \text{of water}}$$

Prob 4.12

Data:

$P_A = 140 \, kPa$
$= 140 \times 10^3 \, N/m^2$

$P_B = 210 \, kPa$
$= 210 \times 10^3 \, N/m^2$



$h_L = ?$ and direction = ?

a) $\gamma_{liq} = 4.5 \, KN/m^3$

b) $\gamma_{liq} = 15 \, KN/m^3$

Sol:

i) Suppose direction from $A \rightarrow B$

$$Z_a + \frac{P_a}{\gamma} + \cancel{\frac{V_a^2}{2g}} = Z_b + \frac{P_b}{\gamma} + \cancel{\frac{V_b^2}{2g}} + h_L$$

$$9 + \frac{140 \times 10^3}{4.5 \times 10^3} = 0 + \frac{210 \times 10^3}{4.5 \times 10^3} + h_L$$

$$\boxed{h_L = -6.55 \text{ m of liquid}}$$

Assumed direction is incorrect. and flow is from section $B \rightarrow A$

b) Suppose direction from $A \rightarrow B$

$$9 + \frac{140 \times 10^3}{15 \times 10^3} = \frac{210 \times 10^3}{15 \times 10^3} + h_L$$

$$\boxed{h_L = 4.33 \text{ m of liquid}}$$

Assumed direction is correct and flow is from $A \rightarrow B$

Prob 4.13

Data:

$P_A = 150\ kN/m^2$

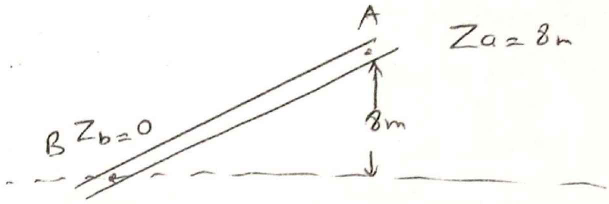
$P_B = 250\ kN/m^2$

Direction of flow = ?

$h_L = ?$

$S\ \gamma_{liq} = 0.85$

$\gamma_{liq} = 8338.5\ N/m^3$



Sol:

Suppose direction of flow from $A \longrightarrow B$

$$Z_a + \frac{P_a}{\gamma} + \cancel{\frac{V_a^2}{2g}} = Z_b + \frac{P_b}{\gamma} + \cancel{\frac{V_b^2}{2g}} + h_L$$

$$8 + \frac{150 \times 10^3}{8338.5} = 0 + \frac{250 \times 10^3}{8338.5} + h_L$$

$$h_L = -3.99 \text{ m of liquid.}$$

Assumed direction is incorrect. The flow is from $B \longrightarrow A$

Prob 4.14

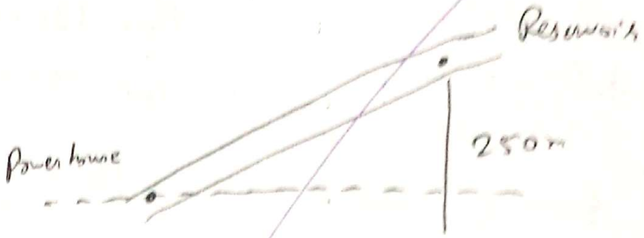
Data:

Fluid = Water

$V = 68 m/s$

$d = 20 cm$

$= 0.2 m$



$A = 0.0314 m^2$

Power of jet = ? (KW)

KW lost in friction b/w jet and reservoir = ?

Sol:

$Power = \gamma Q h_p$

$= (9810)(2.136)(250)$

$\boxed{Power = 5238.54 KW}$

$Q = AV$

$= 0.0314 \times 68$

$Q = 2.136 m^3/s$

Power of jet $= P_j = \gamma Q \left(\frac{V_j^2}{2g}\right)$

$= 4938.~~582~~$ 432 KW

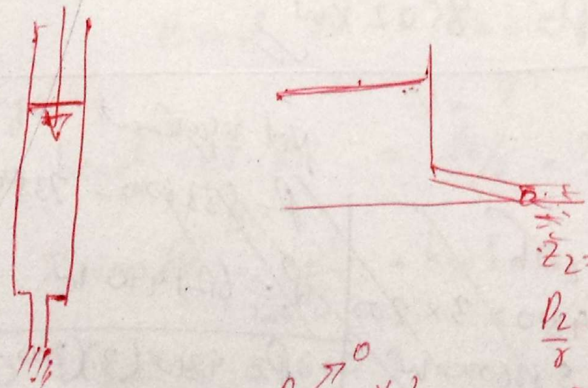
$V = \sqrt{2gh}$

$V^2 = 2gh$

$\boxed{h = \frac{V^2}{2g}}$ → for jet head loss

Lost $P_l = P_L = P - P_j$

$= ~~299.995~~$ 300.108 KW



$z_2 = 0$

$\frac{P_2}{\gamma} = 0$

$z_1 + \cancel{\frac{P_1}{\gamma}}^0 + \frac{V_1^2}{2g} = \cancel{z_2} + \cancel{\frac{P_2}{\gamma}}^0 + \frac{V_2^2}{2g}$

250 +

Prob 4.15
Data:

$Q = 6 m^3/s$

$h_Z = 120 m$

$h_L = 10 m$

Power = ? (kW)

Efficiency = 90%

Sketch EL and HGL:

For pump output

$P_{out} = 9810 \times 6 \times (120+10)$

$P_{out} = 7651.8 \text{ KW}$

Eff =

Sol:

Power requirement for "h"

$P_h = \gamma Q h$

$= 9810 \times 6 \times 120 = 7063.2 \text{ KW}$

Frictional losses

$P_h = \gamma Q h_f$

$= 9810 \times 6 \times 10 = 588.6 \text{ KW}$

Net requirement $= P_h + P_f$

$= 7651.6 \text{ KW}$

Required Power $= 7651.6 \times \frac{100}{90}$

$P = 8502 \text{ KW}$

Efficiency $= \frac{P_{out}}{P_{in}}$

$\frac{90}{100} = \frac{7651.6}{P_{in}}$

$P_{in} = \frac{7651.6}{90} \times 100$

4-16 → 6573.64 hp

Data:

$Z = 200 m$

$h_L = 8 m$

Efficiency = 90%

$Q = 3 m^3/s$

$P = ?$

Sol:

~~$P_h = \gamma Q h$~~

~~$= 9810 \times 3 \times 200$~~

~~$= 5886000 \text{ W}$~~

loss ~~$P = \gamma Q h_L$~~

~~$= 9810 \times 3 \times 8$~~

~~$= 235440 \text{ W}$~~

Net requirement

~~$P = 5886000 + 235440$~~

~~$P = 6121440 \text{ W}$~~

$P_{out} = 9810 (3)(200-8)$

$P = 5650560 \text{ W}$

$P_{out} = 0.9 \times 5650560$

$= 5085504 \text{ W}$

$1 hp = 746 W$

$\boxed{P_{out} = 6817 hp}$

Prob 4.30

Data:

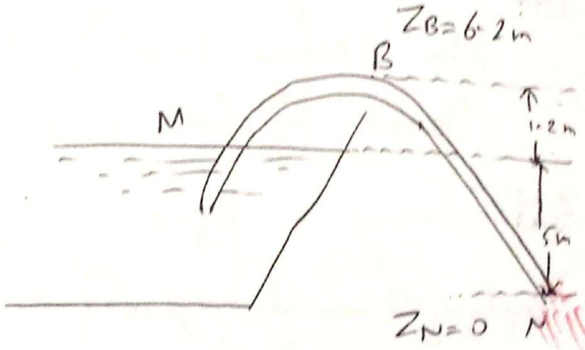
Frictionless flow

$Q = ?$

$h_B = ?$

$d = 15\,cm = 0.15\,m$

$A = 0.0176\,m^2$



Sol:

Applying Bernoulli's eq at B and N

$$Z_B + \frac{V_B^2}{2g} + \frac{P_B}{\gamma} = Z_N + \frac{V_N^2}{2g} + \frac{P_N}{\gamma}$$

$$6.2 + 0 + h_B = 0 + 0$$

$h_B = -6.2$ m of water

$Q = AV$

$Q = 0.0176\,V$

$Q = 0.0176 \times 9.9$

$\boxed{Q = 0.174\,m^3/s}$

$\frac{V^2}{2g} = 0$

$\because$ frictionless flow

Outlet velocity $= \sqrt{2gh}$

$V = \sqrt{2 \times 9.81 \times 5}$

$\boxed{V = 9.90\,m/s}$

Prob 4.31

Data: Friction loss b/w intake and B $= h_1 = 0.6\,m$

" " B and N $= h_2 = 0.9\,m$

Discharge $Q = ?$

Pressure head at B $= P_B/\gamma = ?$

$d = 15\,cm = 0.15\,m$

$A = 0.017\,m^2$

Sol:

$$Z_1 + \frac{P_1}{\gamma}^{=0} + \frac{V_1^2}{2g}^{=0} = Z_N + \frac{P_N}{\gamma}^{=0} + \frac{V_N^2}{2g} + h_1 + h_2$$

$$5 = 0 + \frac{V_N^2}{2g} + 0.6 + 0.9$$

$\boxed{V_N = 8.286\,m/s}$

$Q = A V_N = 0.017 \times 8.286$

$\boxed{Q = 0.14\,m^3/s}$

'B' and 'N'

$$\therefore Z_B + P_B/\gamma + \cancel{V_B^2/2g} = Z_N + P_N/\gamma + \cancel{V_N^2/2g} + h_2$$

$P_B/\gamma = 5.3$ m of water

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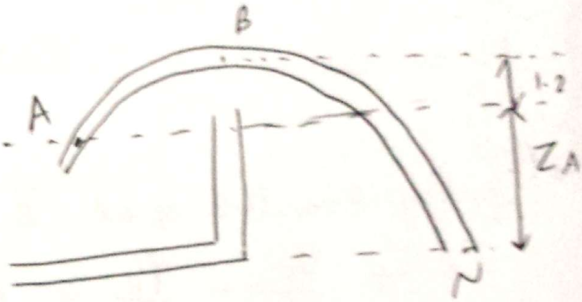
Prob 4.32:

Data:

Min pressure head $= \frac{P_B}{\gamma} = -10\,m$

Height of intake point $Z_A = ?$

Sol:



Applying Bernoulli's equation on A and N

$$Z_A + \frac{P_A}{\gamma} + \frac{V_A^2}{2g} = Z_N + \frac{P_N}{\gamma} + \frac{V_N^2}{2g}$$

$$Z_A = \frac{V_N^2}{2g}$$

→ Applying Bernoulli's eq. on "A" and 'B'

$$Z_A + \overbrace{\frac{P_A}{\gamma}}^{=0} + \overbrace{\frac{V_A^2}{2g}}^{=0} = Z_B + \frac{P_B}{\gamma} + \frac{V_B^2}{2g}$$

$$Z_A = (Z_A + 1.2) - 10 + \frac{V_B^2}{2g}$$

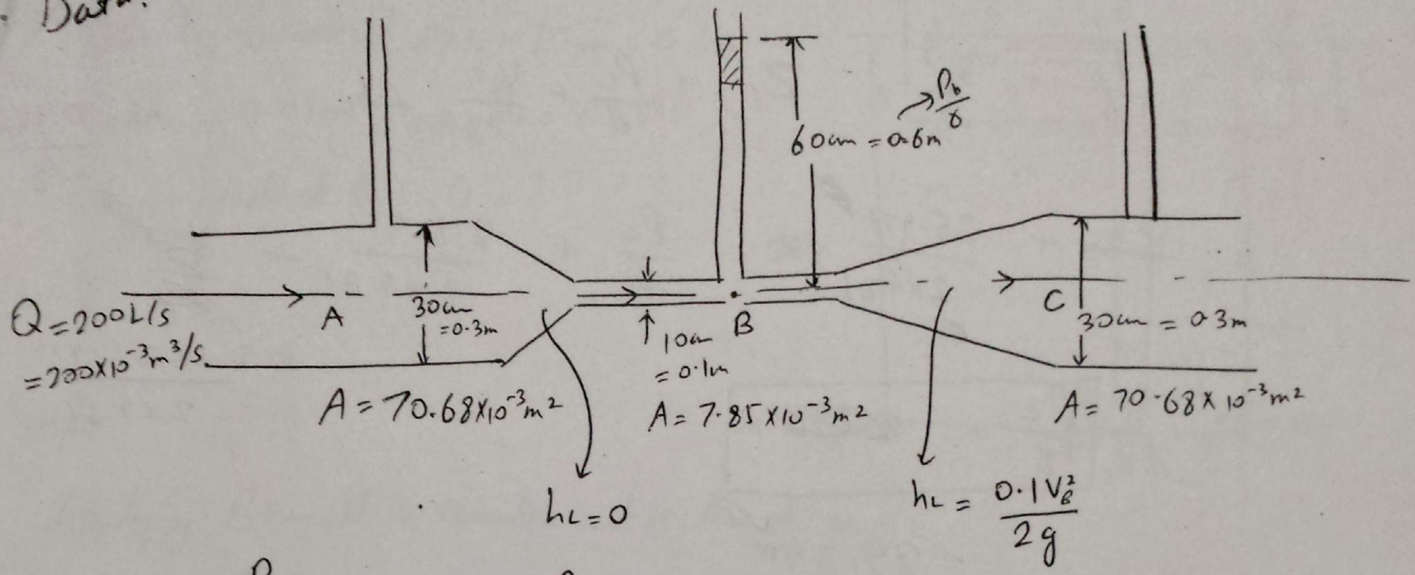
$$\cancel{Z_A} = \cancel{Z_A} + 1.2 - 10 + Z_A \qquad \frac{V_B^2}{2g} = Z_A$$

$$\boxed{Z_A = 8.8\,m}$$

Prob 4.33

OK

Data:



$\frac{P_a}{\gamma} = ?$ $\quad$ $\frac{P_c}{\gamma} = ?$

Sol:

Applying Bernoulli's equation b/w A and B

$$Z_a + \frac{P_a}{\gamma} + \frac{V_a^2}{2g} = Z_b + \frac{P_b}{\gamma} + \frac{V_b^2}{2g}$$

$Z_a = Z_b$

$\because$ elevation/datum is same

$$\frac{P_a}{\gamma} + \frac{2.829^2}{2 \times 9.81} = 0.6 + \frac{25.47^2}{2 \times 9.81}$$

$$\boxed{\frac{P_a}{\gamma} = 33.25\,m}$$

$Q = AV$

$$V_a = \frac{200 \times 10^{-3}}{70.68 \times 10^{-3}}$$

$$\boxed{V_a = 2.829\,m/s}$$

$$V_b = \frac{200 \times 10^{-3}}{7.85 \times 10^{-3}}$$

$$\boxed{V_b = 25.47\,m/s}$$

$$V_c = \frac{200 \times 10^{-3}}{70.68 \times 10^{-3}}$$

$$\boxed{V_c = 2.829\,m/s}$$

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Applying Bernoulli's eq. b/w B and C

$$Z_b + \frac{P_b}{\gamma} + \frac{V_B^2}{2g} = Z_c + \frac{P_c}{\gamma} + \frac{V_c^2}{2g} + h_L$$

$$h_L = \frac{0.1 V_B^2}{2g}$$

$$0.6 + \frac{25.47^2}{2\times 9.81} = \frac{P_c}{\gamma} + \frac{2.829^2}{2\times 9.81} + \cancel{\frac{V_B^2}{2g}} + \frac{0.1\times 25.47^2}{2\times 9.81}$$

$$\boxed{\frac{P_c}{\gamma} = \cancel{0.192}\ m}$$

$= 29.34^m$ ✓

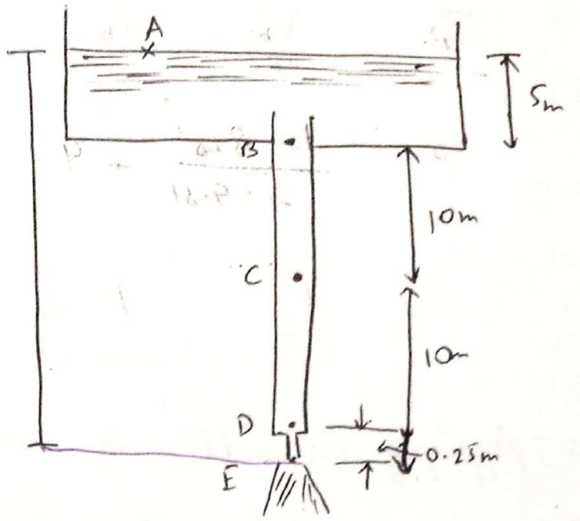
Prob 4.34

$A = 7.85 \times 10^{-3} \, m^2$

Diameter of vertical pipe $= 10 \, cm = 0.1 \, m$

$D_E = 0.07 \, m \Rightarrow A_E = 3.84 \times 10^{-3} \, m^2$

Pressure heads at B, C, D = ?



Sol:

Applying Bernoulli's equation at section A and E

$$Z_a + \frac{P_a}{\gamma} + \frac{V_a^2}{2g} = Z_e + \frac{P_e}{\gamma} + \frac{V_E^2}{2g}$$

$$25 + 0 + 0 = 0 + 0 + \frac{V_E^2}{2g} \Rightarrow V_E^2 = (2g)(25)$$

$$V_E = \sqrt{2 \times 9.81 \times 25}$$

$$\boxed{V_E = 22.147 \, m/s}$$

$\frac{P_a}{\gamma} = \frac{P_E}{\gamma} = 0$ $\because$ water is open to atmosphere

and $\frac{V_a^2}{2g} = 0$ water level is not varying

Now $Q = V_E A_E$

$= (22.147)(3.84 \times 10^{-3})$

$$\boxed{Q = 0.0852 \, m^3/s}$$

Also Area at B, C, D $= 7.85 \times 10^{-3} \, m^2$

$\because Q = AV$

$$V_B = V_C = V_D = \frac{Q}{A} = \frac{0.0852}{7.85 \times 10^{-3}} = 10.848 \, m/s$$

Now Applying Bernoulli's equation at section A and B

$$Z_a + \frac{P_a}{\gamma} + \frac{V_a^2}{2g} = Z_b + \frac{P_b}{\gamma} + \frac{V_b^2}{2g}$$

$$25 + 0 + 0 = 20 + \frac{P_b}{\gamma} + \frac{10.848^2}{2 \times 9.81}$$

$$\boxed{\frac{P_b}{\gamma} = \cancel{9.00} \; -0.998 \, m \text{ of water}}$$

Applying Bernoulli's eq at section A and C

$$Z_a + \frac{V_a^2}{2g} + \frac{P_a}{\gamma} = Z_c + \frac{P_c}{\gamma} + \frac{V_c^2}{2g}$$

$$25 + 0 + 0 = 10 + \frac{P_c}{\gamma} + \frac{10.848^2}{2g}$$

$$\boxed{\frac{P_c}{\gamma} = 9 \text{ m}}$$

Applying Bernoulli's eq at A and D

$$Z_a + \frac{V_a^2}{2g} + \frac{P_a}{\gamma} = Z_D + \frac{P_D}{\gamma} + \frac{V_D^2}{2g}$$

$$25 + 0 + 0 = 0.25 + \frac{P_D}{\gamma} + \frac{10.848^2}{2 \times 9.81}$$

$$\boxed{\frac{P_D}{\gamma} = 18.75 \text{ m}}$$

Prob 4.35

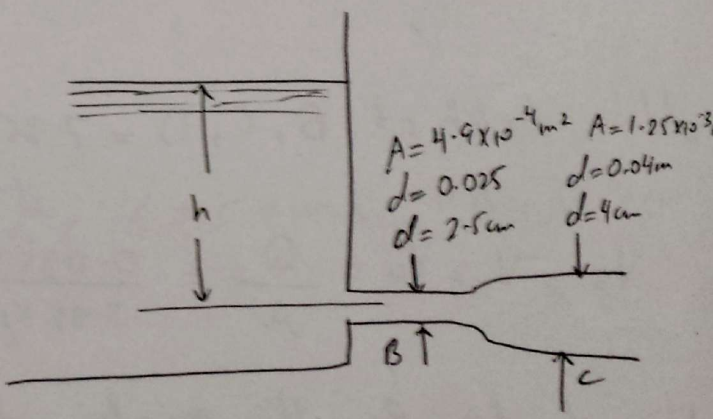
Data:

a) If $h = 2$m

$V_B = ?$ $\frac{P_B}{\gamma} = ?$

b) Q in L/s = ?

If tube is ~~cutt~~ cut off at B then Q = ?



Applying Bernoulli's equation

$$Z_a + \frac{P_a}{\gamma} + \frac{V_a^2}{2g} = Z_b + \frac{P_b}{\gamma} + \frac{V_B^2}{2g}$$

$Q = AV$

$$V_B = \frac{Q}{4.9 \times 10^{-4}}$$

Scanned by CamScanner

Velocity at 'C' $= V_c = \sqrt{2gh}$
$= 6.2641$

$A_B V_B = A_C V_C$

$$V_B = \frac{(6.264)(0.04)^2}{(0.025)^2}$$

$$\boxed{V_B = 16.035 \text{ m/s}}$$

Applying Bernoulli's equation

$$Z_A + \frac{P_A}{\gamma} + \frac{V_A^2}{2g} = Z_B + \frac{P_B}{\gamma} + \frac{V_B^2}{2g}$$

$$\frac{P_B}{\gamma} = 11.1064\text{m}$$

Rate of flow in l/s

$Q_C = A_C V_C \times 1000$

$= 7.8676 \times 1000 = 7867.6$ l/sec

Rate of flow through 'B'

$Q_B = A_B V_C$

$$= \frac{\pi (0.025)^2}{4} \times 16.035 \times 1000$$

$Q = 7867.6$ l

Prob 4.36

Data:

$h = 3.5m$

$d_B = 5cm = 0.05m \Rightarrow A = 1.963 \times 10^{-3} m^2$

$d_c = 6.5cm = 0.065m \Rightarrow A = 3.318 \times 10^{-3} m^2$

Sol:

$V_c = \sqrt{2gh}$

$= 8.287 m/s$ $\qquad V_B = 14.0064$

Applying Bernoulli's equation

$$Z_A + \frac{P_A}{\gamma} + \frac{V_A^2}{2g} = Z_B + \frac{P_B}{\gamma} + \frac{V_B^2}{2g}$$

$$\frac{P_B}{\gamma} = 6.5 \text{ m of water}$$

Flow rate $= Q_c = A_c V_c$

$= (8.287) \left(\cancel{\frac{\pi (0.065)^2}{4}} \right) \cancel{\times 1000}$ 3.318×10^{-3}

$Q_c = \cancel{27.5}$ 0.02749 m^3/s $\longrightarrow 16.27 L/s$

$= 27.49 L/s$

Flow rate through 'B'

$Q_B = A_B V_B$

$= \cancel{27.5 L/s}$ $1.963 \times 10^{-3} \times 14.0064$

$= 24.49 L/s$

$1000 L = 1 m^3$

$1 L = 10^{-3} m^3$