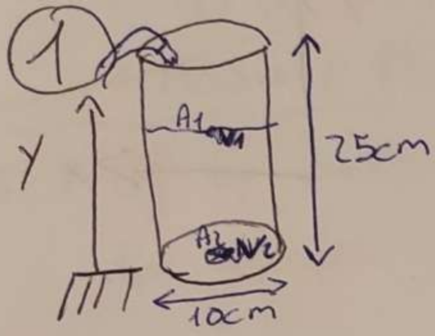
Asier Azpiri

PHY250

HW_2



$Q = 2{,}4 \cdot 10^{-4}\ m^3/s \quad A_2 = 1{,}5 \cdot 10^{-4}\ m^2$

Volume flow rate from The Tube

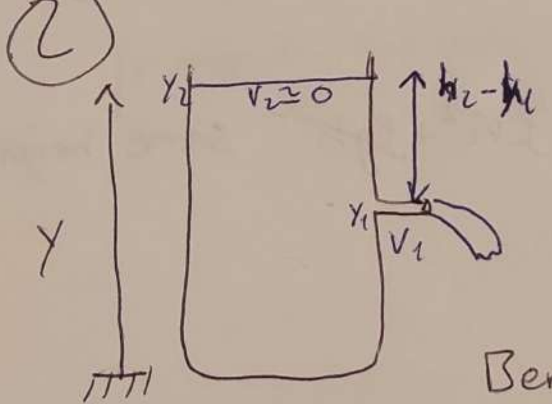
$Q = A_2 V_2 \Rightarrow V_2 = \frac{2{,}4 \cdot 10^{-4}\ m^3/s}{1{,}5 \cdot 10^{-4}\ m^2} = 1{,}6\ m/s$

$Q = A_1 V_1 \Rightarrow V_1 = \frac{Q}{A_1} \simeq 0\ m/s$ (since A_1 is so big That V_1 is almost 0 m/s)

Bernoulli's Equation

$\cancel{P_0} + \cancel{\frac{1}{2}\rho_w V_1^2} + \cancel{\rho} g h_1 = \cancel{P_0} + \frac{1}{2}\cancel{\rho_w} V_2^2 + \cancel{\rho g h_2}$ $\quad h_2 = 0m$

$g h_1 = \frac{V_2^2}{2} \Rightarrow h_1 = \frac{V_2^2}{g} = \boxed{0{,}13\ m}$



From The equation of continuity we have

$$A_1 V_1 = A_2 V_2$$

$$V_2 = \frac{A_1 V_1}{A_2}$$

Bernoulli's Equation

$\cancel{P_0} + \frac{1}{2}\cancel{\rho} V_1^2 + \cancel{\rho} g h_1 = \cancel{P_0} + \frac{1}{2}\cancel{\rho} V_2^2 + \cancel{\rho} g h^2$

$$g(h_2 - h_1) = \frac{1}{2}(V_1^2 - V_2^2)$$

$$2g(h_2 - h_1) = V_1^2 - V_2^2$$

$$V_1^2 - \frac{A_1^2 V_1^2}{A_2^2} = 2gh$$

$$V_1^2\left(1 - \frac{A_1^2}{A_2^2}\right) = 2gh$$

$$\boxed{V_1 = \sqrt{\frac{2gh}{\cancel{\left(1 - \frac{A_1^2}{A_2^2}\right)} 1}}} \qquad A_1 << A_2$$

$$\boxed{V_1 = \sqrt{2gh}}$$

where $h = h_2 - h_1$

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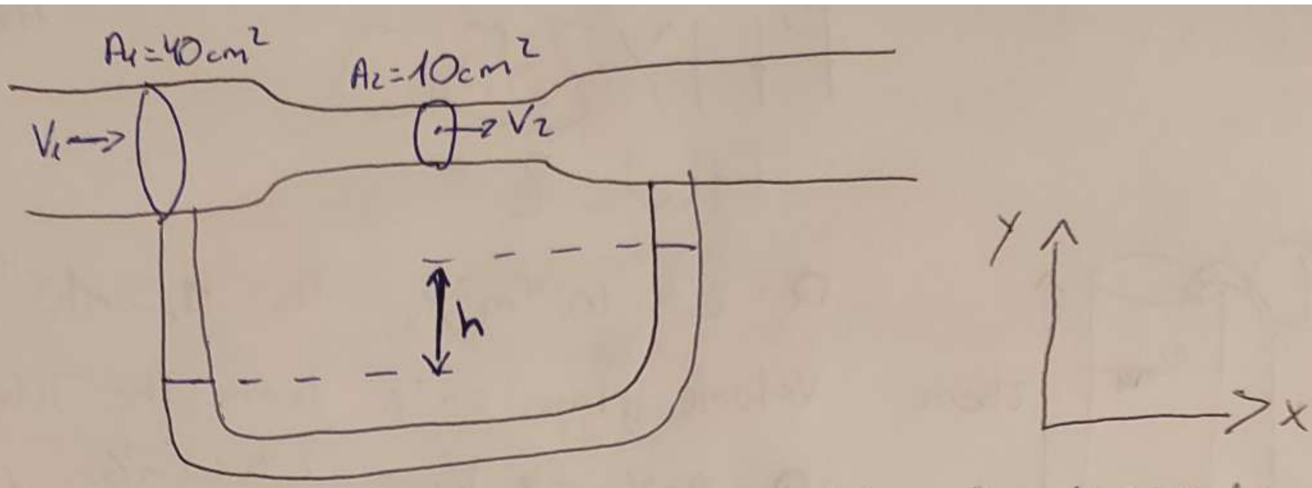


$Q = 6 \cdot 10^{-3} \frac{m^3}{s}$ $\rho_w = 997 \frac{kg}{m^3}$ $\rho_{Hg} = 13600 \frac{kg}{m^3}$

a) Continuity Equation

$A_1 V_1 = 6 \cdot 10^{-3} m^3/sec$

$V_1 = \frac{6 \cdot 10^{-3} m^3/sec}{40 \cdot 10^{-4} m^2}$

$\boxed{V_1 = 1,5 m/s}$

$A_2 V_2 = 6 \cdot 10^{-3} m^3/sec$

$V_2 = \frac{6 \cdot 10^{-3} m^3/sec}{10 \cdot 10^{-4} m^2}$

$\boxed{V_2 = 6 m/sec}$

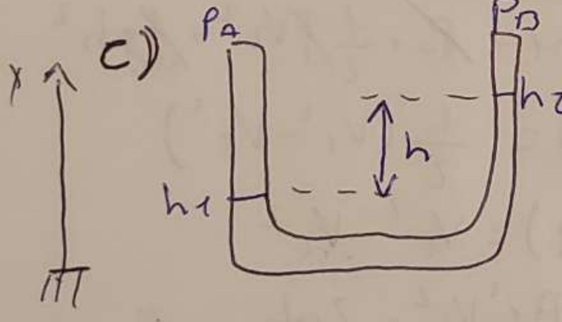
b) Bernoulli's Equation

$P_1 + \frac{1}{2} \rho_w V_1^2 + \cancel{\rho g h} = P_2 + \frac{1}{2} \rho_w V_2^2 + \cancel{\rho g h}$ same height

$(P_1 - P_2) = \frac{\rho_w}{2} (V_2^2 - V_1^2)$

$\boxed{\Delta P = 16824 \text{ Pa}}$

c)



Bernoulli's Equation

$P_1 + \rho_{Hg} g h_1 + \cancel{\frac{1}{2} \rho_{Hg} V_1^2} = P_2 + \cancel{\rho_{Hg} V_2^2} + \rho_{Hg} g h_2$

No velocities in This situation (They are static)

$(P_1 - P_2) = \rho_{Hg} \cdot g \cdot (h_2 - h_1)$

$\frac{\Delta P}{\rho_{Hg} \cdot g} = \Delta h$

$\boxed{0,126 m = \Delta h}$

(4) Since the liquid is in free fall motion, we can use $V^2 = V_0^2 + 2gy$ (we would reach to the same conclusion using Bernoulli's equation, since pressure is constant).

Continuity equation: $A_1 V_1 = A_2 V_2$ $\quad A = \pi r^2$

$$V_0 \cancel{\pi} r_0^2 = \sqrt{V_0^2 + 2gy} \cdot \cancel{\pi} r^2$$

$$r = \sqrt{\frac{V_0 r_0^2}{\sqrt{V_0^2 + 2gy}}} = \sqrt{\frac{V_0}{\sqrt{V_0^2 + 2gy}}}\, r_0$$

b) Given $V_0 = 1{,}2\,m/s$ and $r = \frac{r_0}{2}$, solve for y

$$\frac{\cancel{r_0}}{2} = \sqrt{\frac{V_0}{\sqrt{V_0^2 + 2gy}}}\,\cancel{r_0}$$

$$\left(\frac{1}{2}\right)^2 = \left(\sqrt{\frac{V_0}{\sqrt{V_0^2 + 2gy}}}\right)^2$$

$$\left(\frac{1}{4}\right)^2 = \left(\frac{V_0}{\sqrt{V_0^2 + 2gy}}\right)^2$$

$$\frac{1}{16} = \frac{V_0^2}{V_0^2 + 2gx}$$

$$\frac{V_0^2 + 2gx}{\cancel{16(V_0^2 + 2gy)}} = \frac{16 V_0^2}{\cancel{16(V_0 + 2gy)}}$$

$$y = \frac{15(1{,}2\,m/s)^2}{2 \cdot 9{,}8\,m/s^2} \Rightarrow \boxed{y = 1{,}1\,m}$$