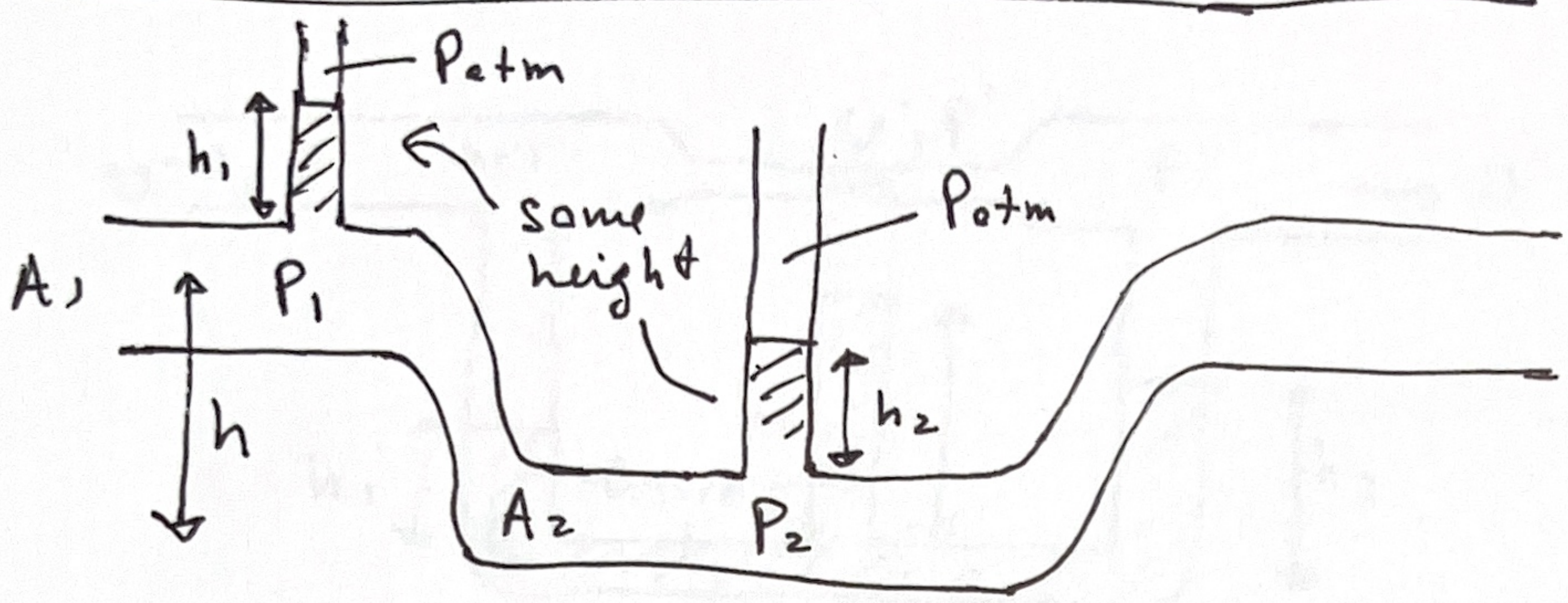
Solution to Venturi-like meter problem



Clearly $P_1 = \rho g h_1 + P_{atm}$, $P_2 = \rho g h_2 + P_{atm}$,

$h_1 = h_2 \Rightarrow P_1 = P_2$

Bernoulli :

$$\cancel{P_1} + \frac{1}{2}\rho v_1^2 = \cancel{P_2} + \frac{1}{2}\rho . v_2^2 - \rho g h$$

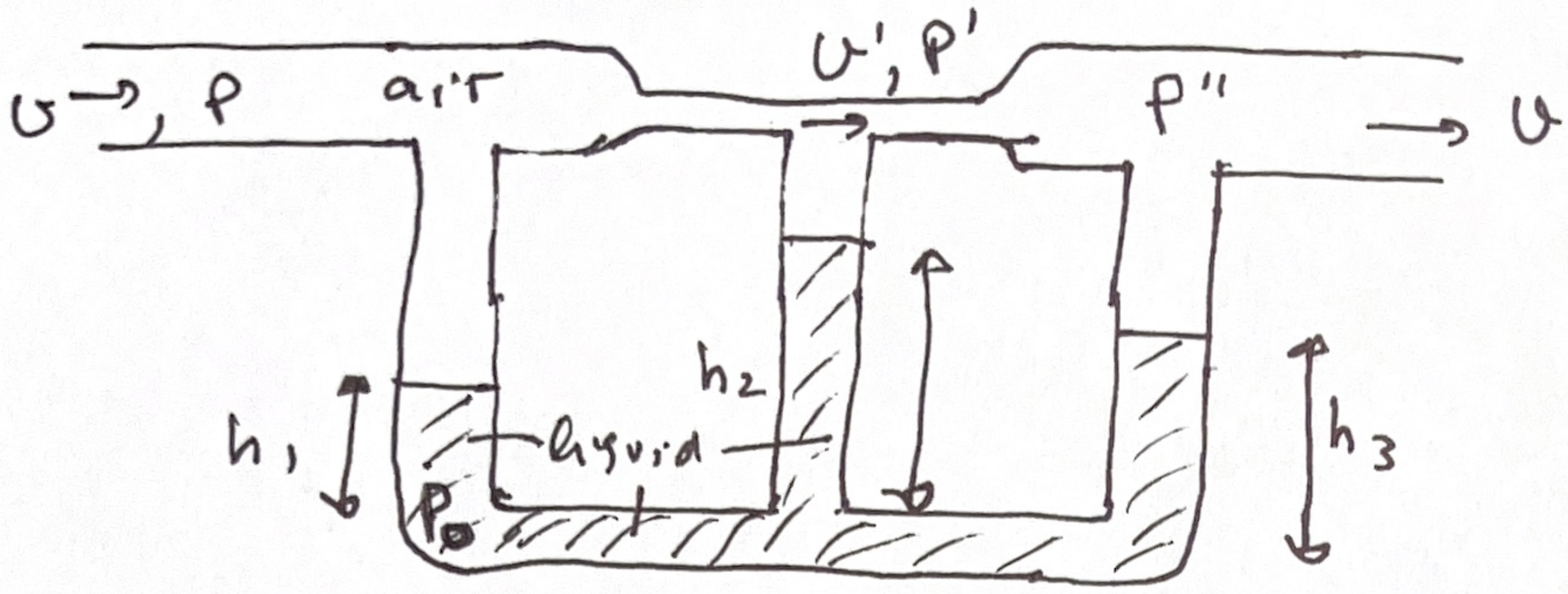
$$A_1 v_1 = A_2 v_2 \Rightarrow v_2 = \frac{A_1}{A_2} v_1$$

since $A_1 = 2A_2 \Rightarrow v_2 = 2v_1$

$$\Rightarrow \frac{1}{2}\cancel{\rho} v_1^2 = 2\cancel{\rho} v_1^2 - \cancel{\rho} g h \Rightarrow gh = \frac{3}{2} v_1^2$$

$$\Rightarrow \boxed{h = \frac{3}{2}\frac{v_1^2}{g}}$$

Solution to



According to Bernoulli

$$P + \frac{1}{2}\rho_{air}v^2 + \rho_{air}gh = \text{const.}$$

here, h is the same everywhere

$v' > v$ since the tube is narrower.

then $P + \frac{1}{2}\rho_{air}v^2 = P' + \frac{1}{2}\rho_{air}v'^2 \Rightarrow P' < P$

At the bottom, P_0 is the same everywhere, so, with ρ the density of the liquid at the bottom

$$P_0 = \rho g h_1 + P = \rho g h_2 + P'$$

since $P' < P \Rightarrow h_2 > h_1$. For the same reason, $h_2 > h_3$

Now why is $h_1 < h_3$? By Bernoulli they should be the same.

Reason is, there is a pressure drop between the left and the right, $P'' < P$, due to energy loss due to friction and turbulence as air moves through the tube, these effects are not considered in Bernoulli law