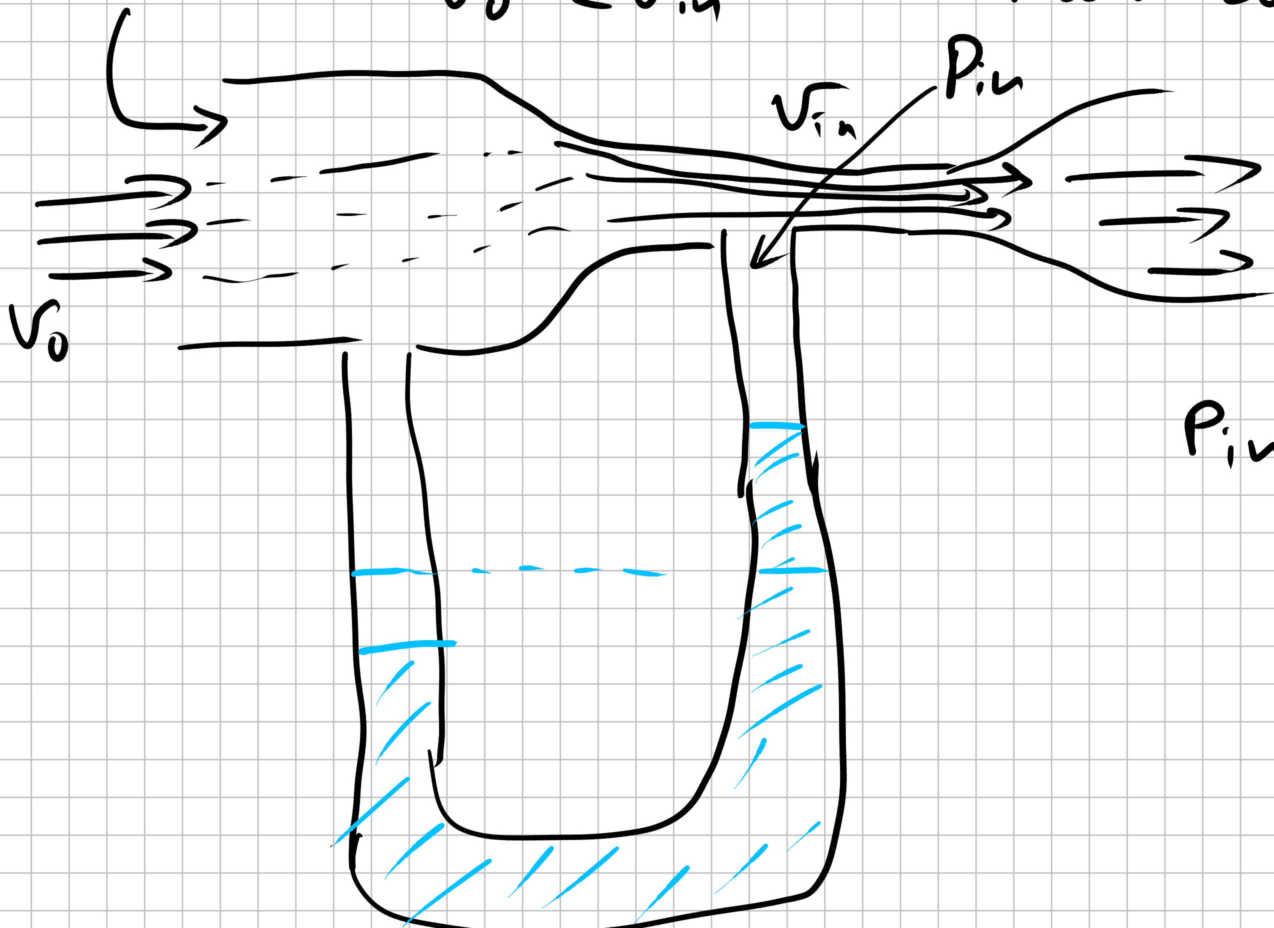
Bernuli equation

$$\boxed{\rho \frac{v^2}{2} + \rho g h + P = \text{constant}}$$

For incompressible fluids

No drag.

P_0 $\quad v_0 < v_{in} \iff$ Flow conservation

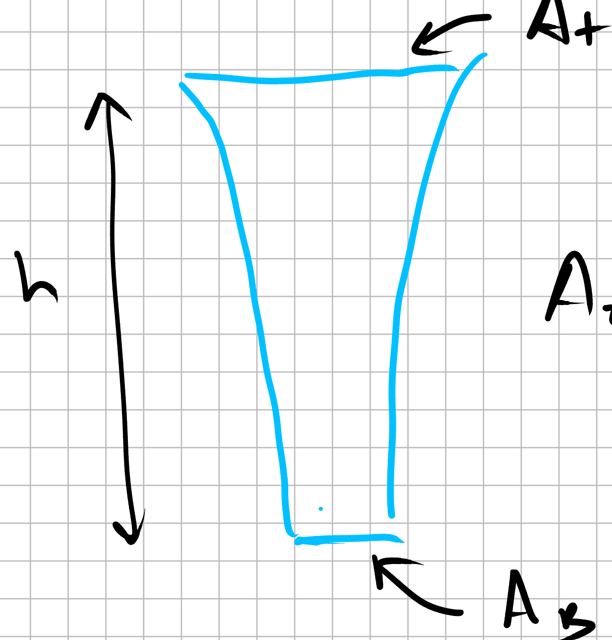


$P_{in} < P_0$

$$P_T + \rho g h + \rho \frac{v_T^2}{2}$$
$$\|$$
$$P_{ATM}$$
$$\|$$
$$P_B + \cancel{\rho g \cdot 0} + \rho \frac{v_B^2}{2}$$

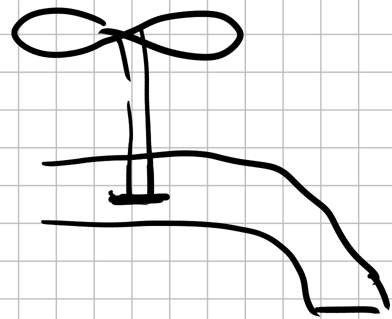
if we want continuous flow $\Leftrightarrow v_T = v_B$

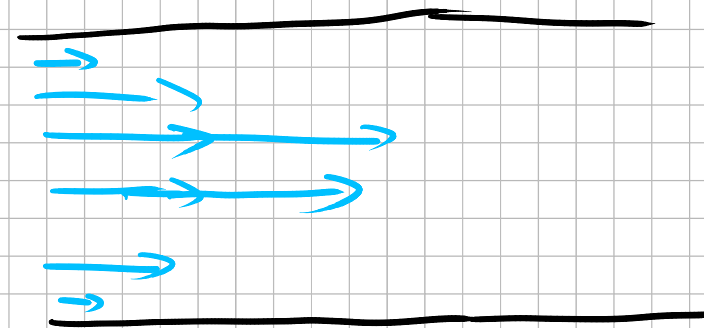
Reality



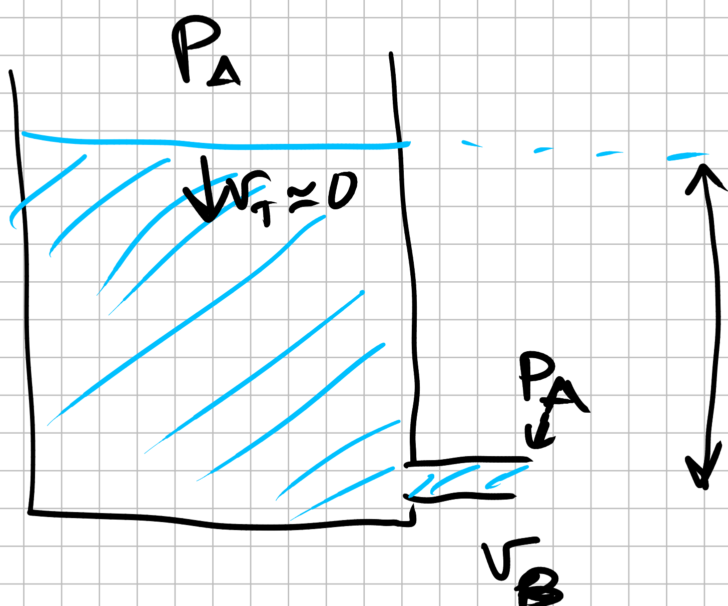
$A_t > A_B$

$h_{critical} \Rightarrow A_B = 0$

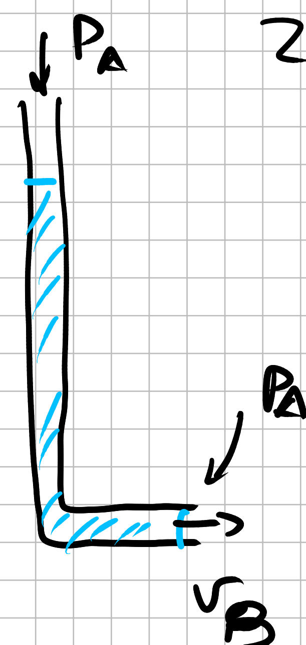




1st case



2nd case



Top $= P_A + \rho g h + \rho \frac{v_T^2}{2}$

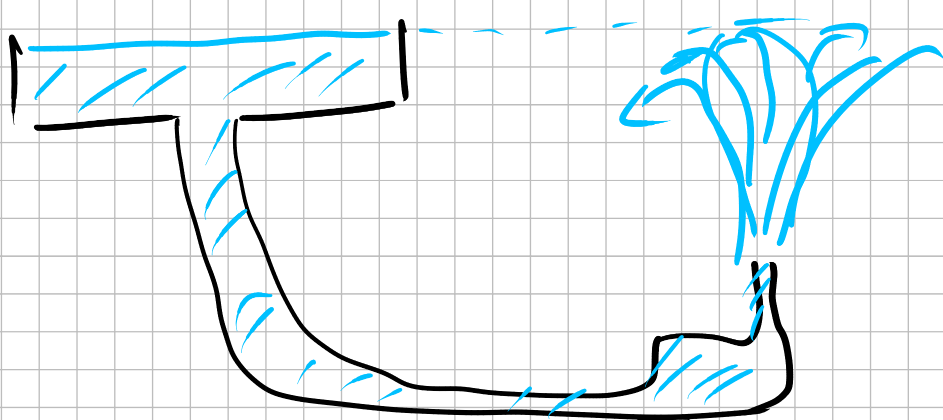
Bot $= P_A + \rho \frac{v_B^2}{2}$

Flow conservation (Q)

$$A \cdot v = \text{constant} \Rightarrow v_{Top} \simeq 0$$

$$\cancel{P_A} + \cancel{\rho} g h = \cancel{P_A} + \cancel{\rho}\frac{v_B^2}{2}$$

$$v_B = \sqrt{2gh}$$



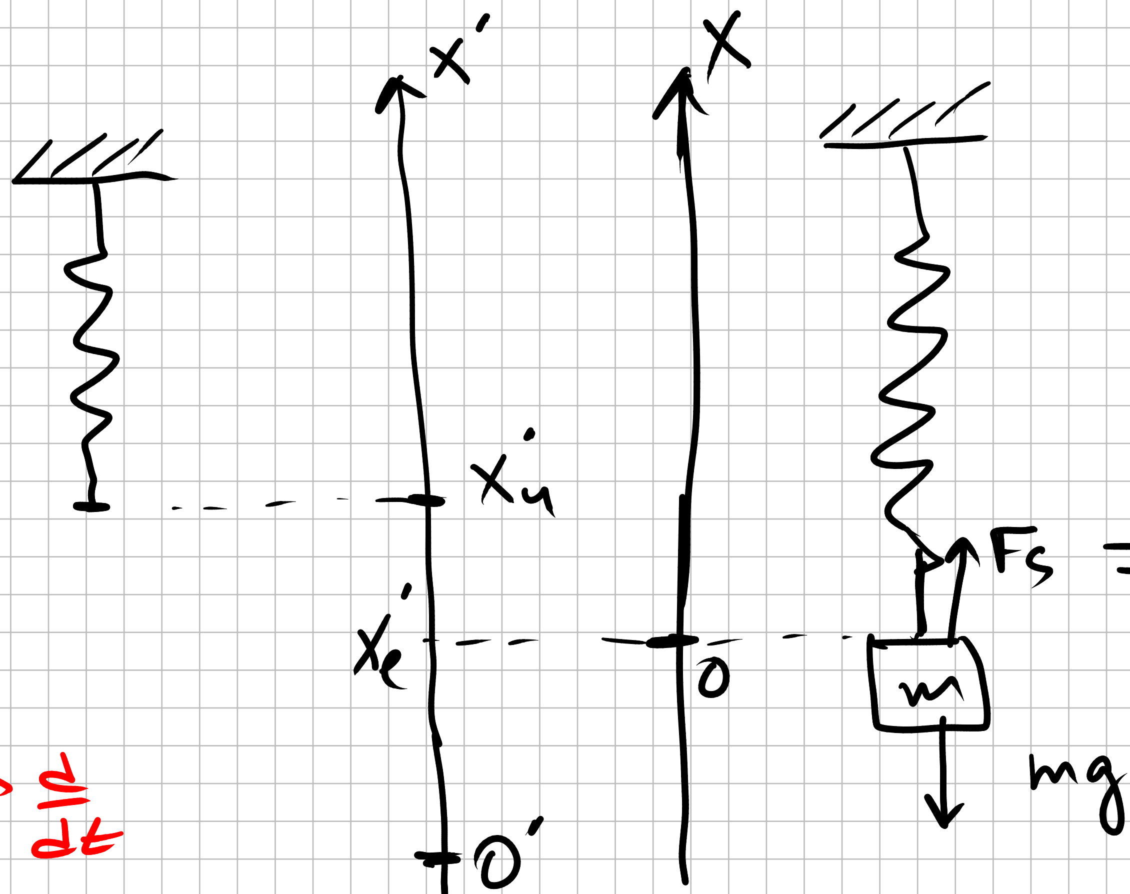
1st case

2nd case

$v_T = v_B \Rightarrow$ leads to paradox

since we have to change crossection

Oscillators



' coordinate system

$$F_s = -k(x' - x'_u)$$

$$\bullet \leftrightarrow \frac{d}{dt}$$

$$m\ddot{x}' = ma' = -k(x' - x'_u) - mg$$

$$= -k((x' - x'_e) - (x'_u - x'_e)) - mg$$

For equilibrium:

$$ma = 0 = -k(x'_e - x'_u) - mg = 0$$

$$-k(x'_e - x'_u) = mg$$

$$m\ddot{x}' = -k(x' - x'_e) + \underbrace{\cancel{k(x'_u - x'_e) - mg}}$$

$$\boxed{m\ddot{x}' = -k(x' - x'_e)}$$

system of coordinates change

$$x' - x'_e = X$$

$$\ddot{X} = -\underbrace{\frac{k}{m}}_{=\omega^2} X \Rightarrow \boxed{\ddot{X} = -\omega^2 X}$$

harmonic oscillator equation