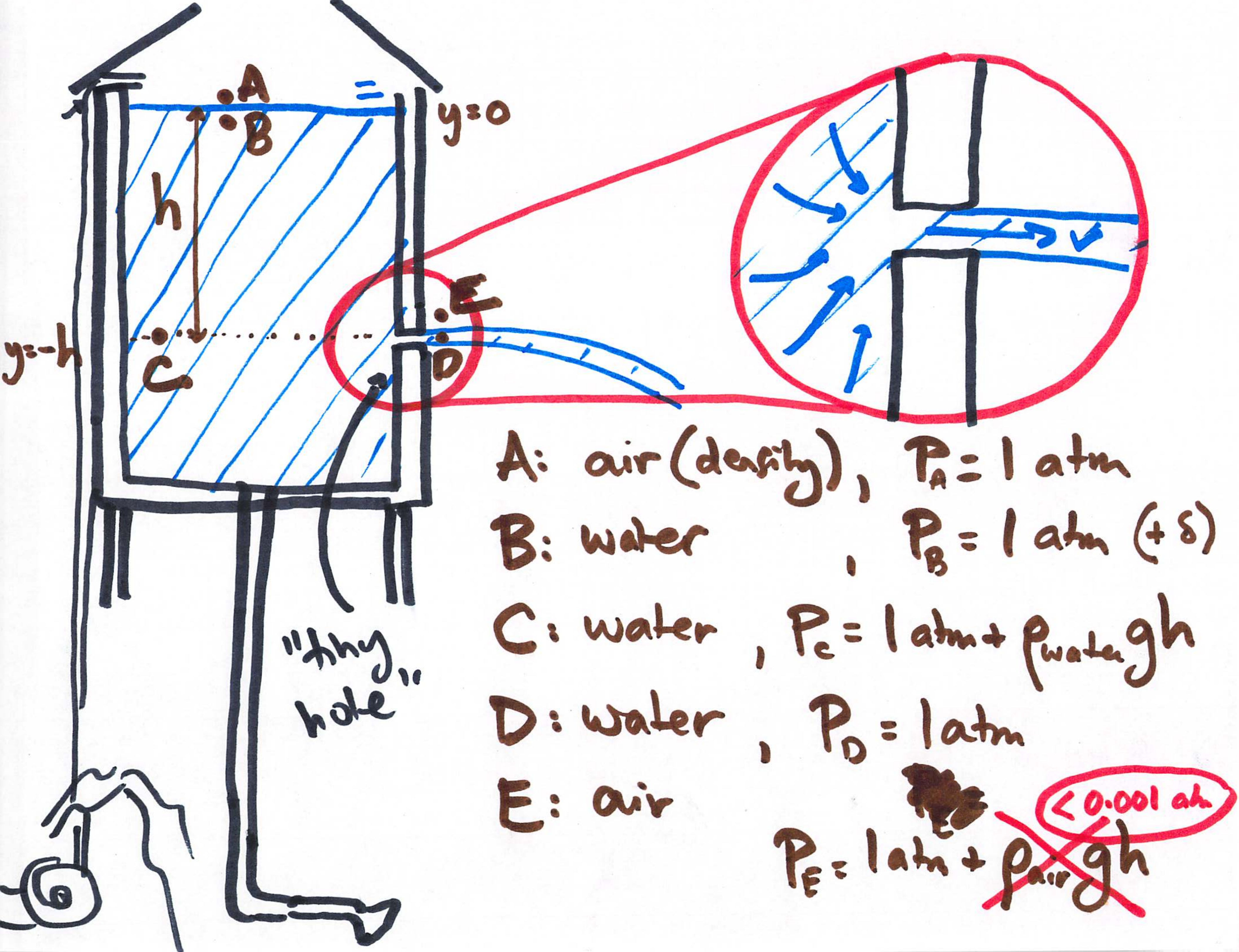
2013-12-03

- Bernoulli's principle
  equation
- surface tension + viscosity
  - dimensions
  - rough calculations
  - when do they <u>matter</u>?
- small is <u>different</u> from big.



A: air (density), $P_A = 1\ \text{atm}$

B: water, $P_B = 1\ \text{atm}\ (+\delta)$

C: water, $P_C = 1\ \text{atm} + \rho_{water} g h$

D: water, $P_D = 1\ \text{atm}$

E: air

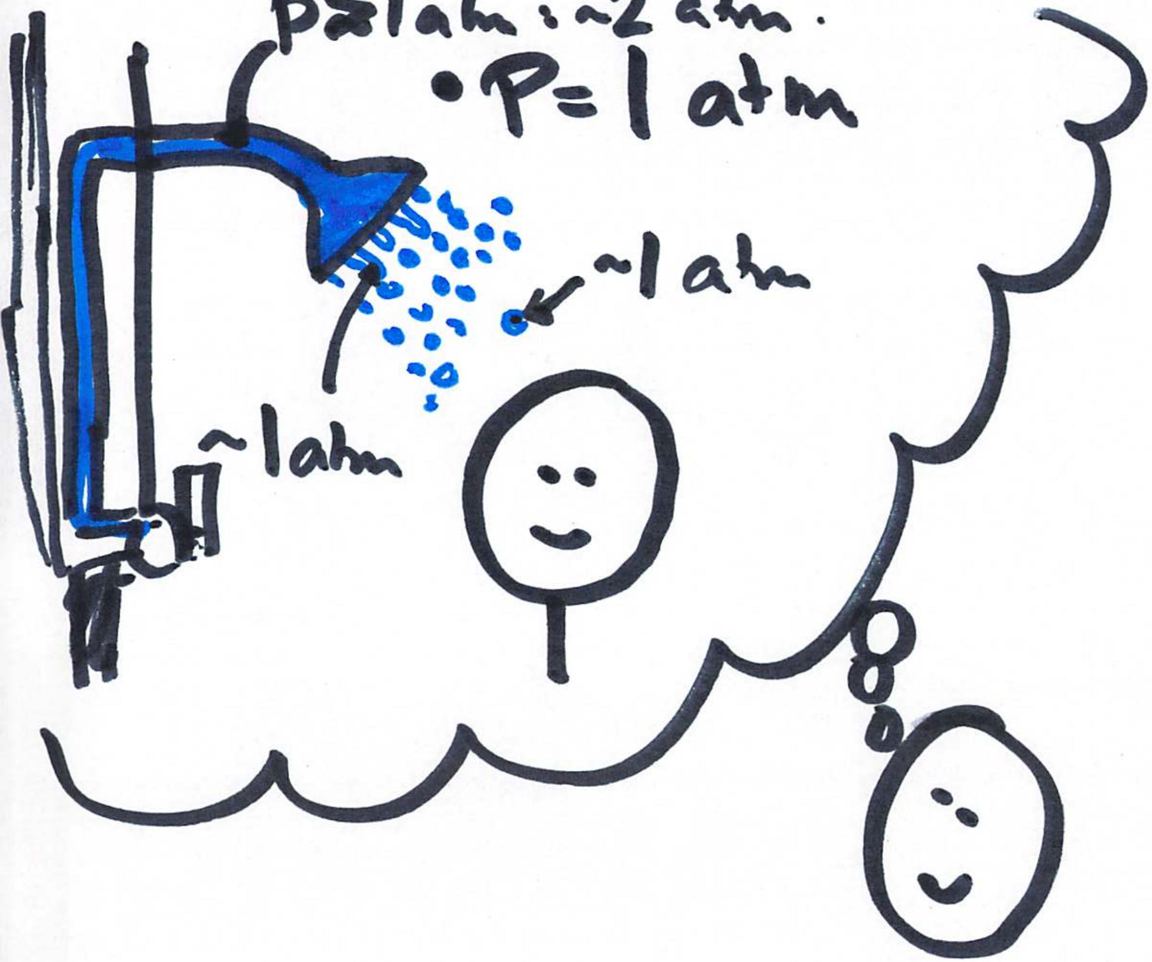
$P_E = 1\ \text{atm} + \cancel{\rho_{air} g h}$ < 0.001 atm

Bernoulli: $\underbrace{P}_{\text{pressure}} + \underbrace{\frac{1}{2}\rho v^2}_{\text{kinetic energy density}} + \underbrace{\rho g h}_{\text{potential energy density}} + \cdots = \text{const.}$

$\frac{\text{energy}}{\text{volume}} = \frac{\text{force}}{\text{area}} \cdot \frac{\text{length}}{\text{length}}$

(only <u>differences</u> matter.)

If a fluid is incompressible: Bernoulli's constant is the <u>same</u> <u>everywhere</u> in the fluid


P≥1atm : ~2 atm.
• P = 1 atm
~1 atm
~1atm

$$@B: \underbrace{P_B}_{\underbrace{1\,\text{atm}}_{10^5 \frac{N}{m^2}}} + \frac{1}{2}\underbrace{\rho}_{\frac{1000\,kg}{m^3}} \underbrace{v_B^2}_{0\frac{m}{s}} + \rho \underbrace{g}_{10\frac{m}{s^2}} \underbrace{h_B}_{0\,m} = 100{,}000 \frac{kg}{m s^2}$$

$$\frac{kg\frac{m}{s^2}}{m^2} = \frac{kg}{m s^2}$$

$$@C: \underbrace{P_C}_{?} + \underbrace{\cancel{\frac{1}{2}\rho v_C^2}}_{0} + \rho \underbrace{g}_{10\frac{m}{s^2}} \underbrace{h_C}_{-2m} =$$

$h_C = -h$

If $\underline{\underline{\text{constant}}}$: $P_C + \rho g h_C = P_B + 0 + 0$

$$\boxed{P_C} = P_B - \rho g h_C = \boxed{P_B + \rho g h}$$

@D $\underbrace{P_D}_{1\,atm} + \frac{1}{2}\rho \underbrace{v_D}_{?}^2 + \rho g \underbrace{h_D}_{\substack{-h \\ -2m}}$

If <u>constant</u>.

$$P_B + 0 + 0 = P_c + \rho g h_c + 0 = P_D + \frac{1}{2}\rho v_D^2 + \rho g h_D$$

$$P_B = 1\,atm = P_D$$

$$\cancel{P_B} = \cancel{P_D} + \frac{1}{2}\rho v_D^2 + \rho g h_D$$

$$\frac{1}{2}\rho v_D^2 = -\rho g h_D \Rightarrow \boxed{v_D = \sqrt{2gh}}$$