2A <u>CH13</u> <u>fluids</u> 11-15-13

P = Pressure = $\dfrac{\text{Force}}{\text{area}}$ (CH 11)

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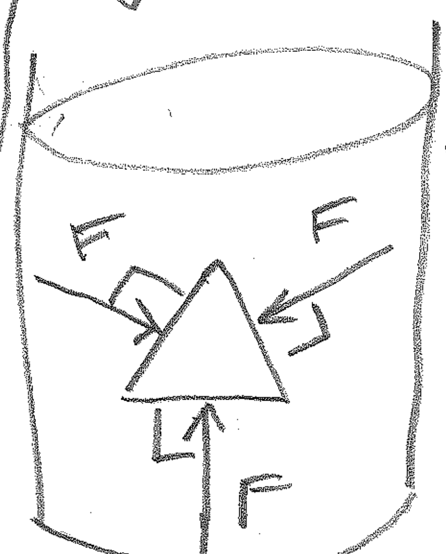
Pascal units: $\dfrac{N}{m^2} = Pa$

density = $\dfrac{\text{mass}}{\text{volume}}$

CONTAINER of H_2O w/ submerged object.

fluid at rest



WOOD object triangle <u>under water</u>

** F ⊥ surface

$\vec{F}$ = fluid force

FIG 13.3

** ⊥ = perpendicular

Pascal's LAW: $P = P_{ATM} + \rho_\ell g h$

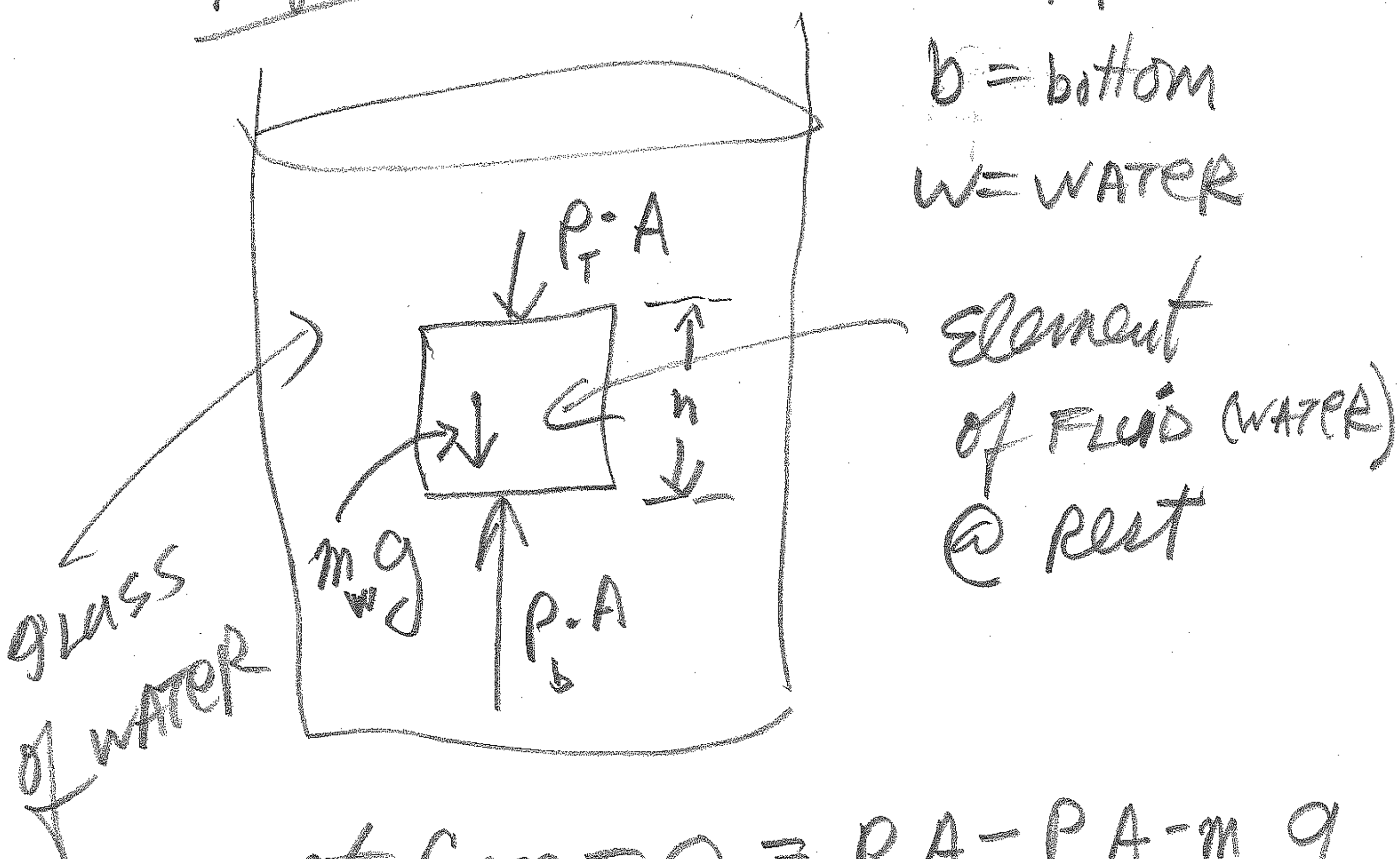
ℓ = liquid; h BELOW SURFACE

T = TOP

b = bottom

W = WATER

Fig. 13.4



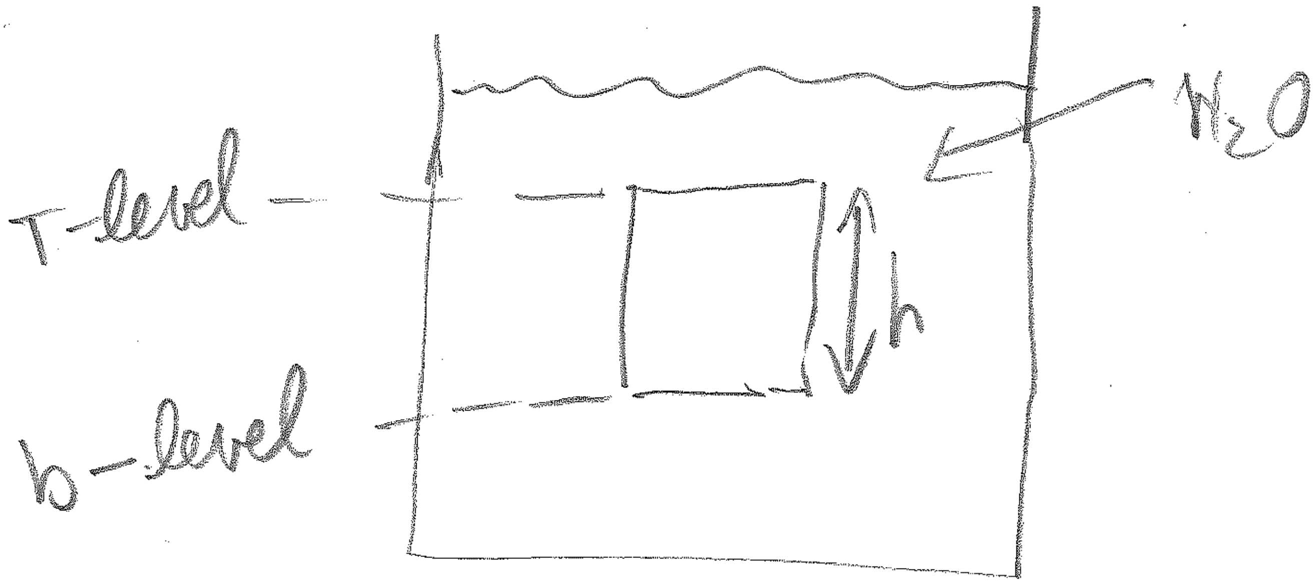
$$\text{net force} = 0 = P_b A - P_T A - m_w g$$

$$m_w = \rho_w \cdot V = \rho_w \cdot h \cdot A$$

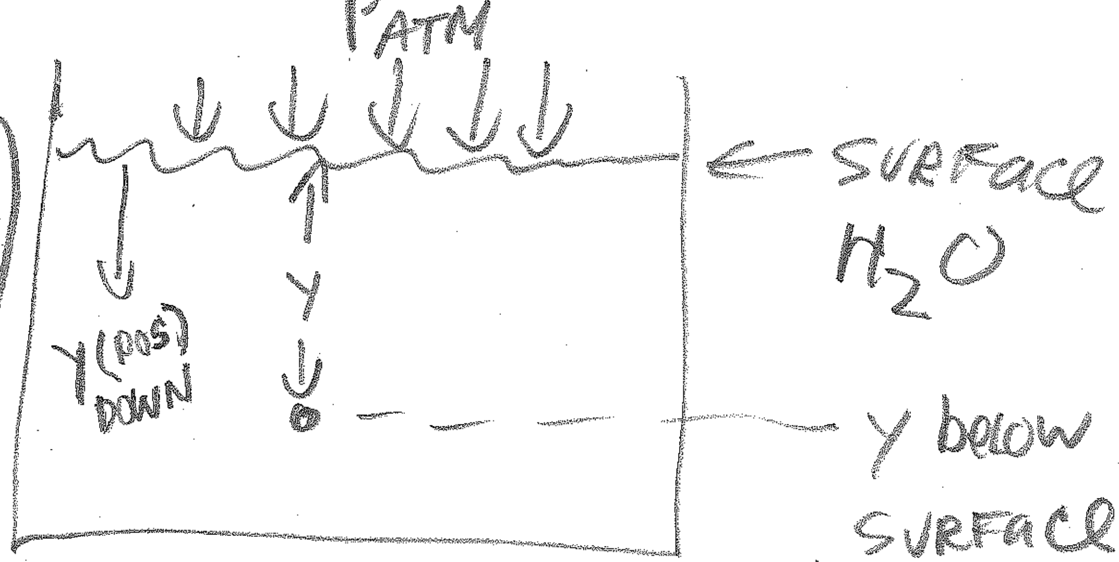
(A = TOP, bottom area)

$$P_b = \frac{P_T \cdot A + \rho_w \cdot h \cdot A \cdot g}{A}$$

$$\boxed{p_b = p_T + \rho_w g h}$$



$$\boxed{P = P_{ATM} + \rho_W g y}$$



$$P_{ATM} = 1.036 \times 10^5 \frac{N}{m^2} (Pa)$$

Simple manometer:

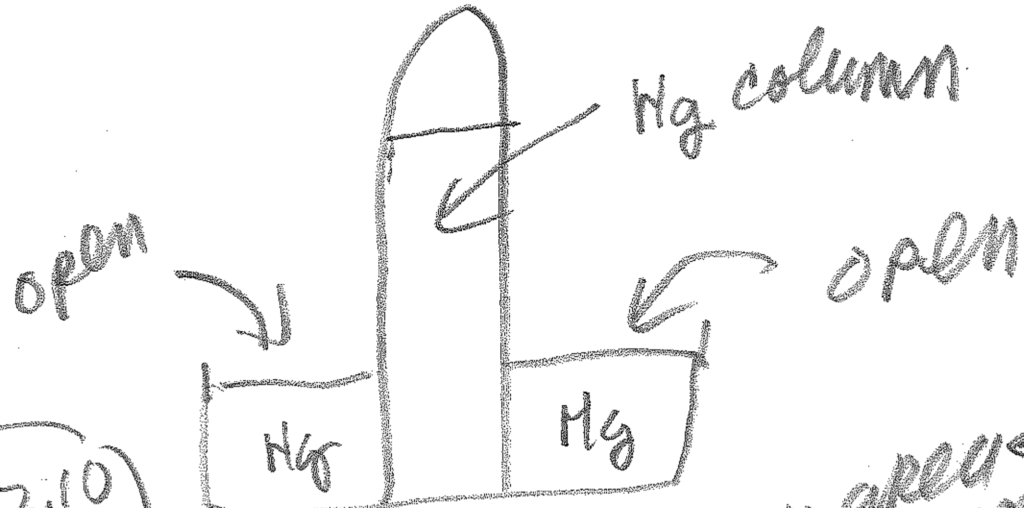
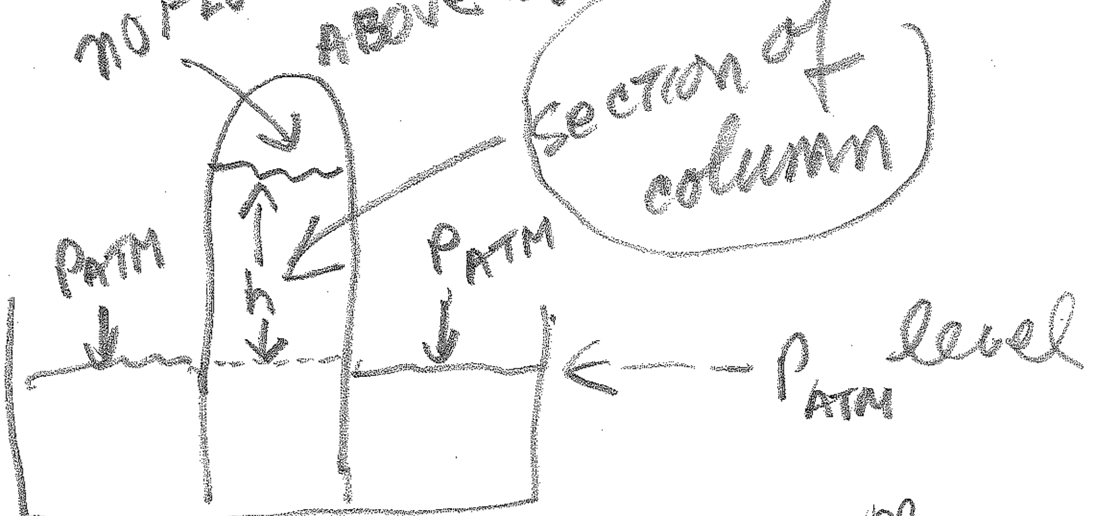
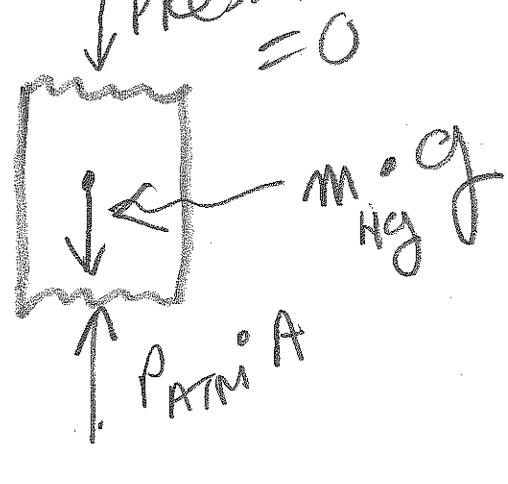


Fig 13.10

no FLUID IN VACCUM AREA ABOVE Hg COLUMN ($P = 0$: ZERO PRESSURE)



column section:



$$m_{HG} \cdot g = P_{ATM} \cdot A$$

$$\rho_{HG} \cdot A \cdot h \cdot g = P_{ATM} \cdot A$$

$$\rho_{Hg}\, h\, g = P_{ATM}$$

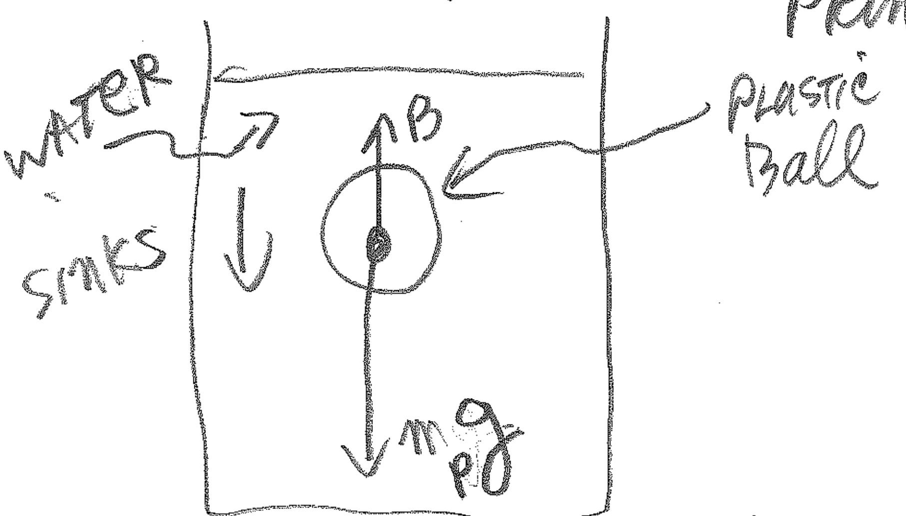
$$h = \frac{P_{ATM}}{g \cdot \rho_{Hg}} = 760\,mm$$

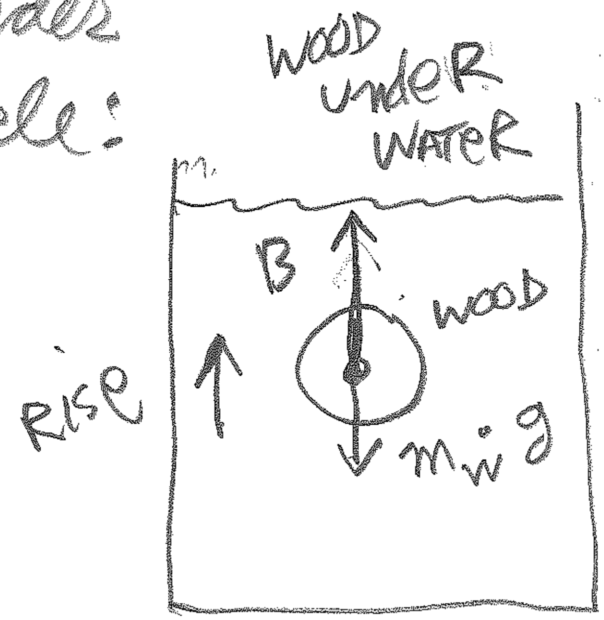
when $P_{ATM} = 1.036 \times 10^{5} \frac{N}{m^2}$

sec. 13.3

B = BUOYANT FORCE

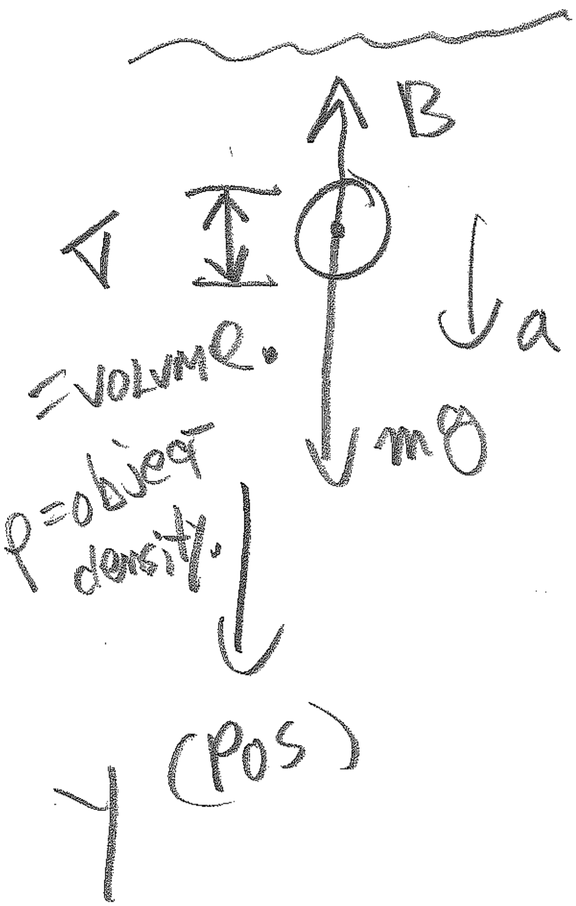
*Archimedes' Principle:





B = weight of WATER DISPLACED by object.*

Example: I. Sinking object under surface of liquid (l)



$$\Sigma F_y = mg - B$$

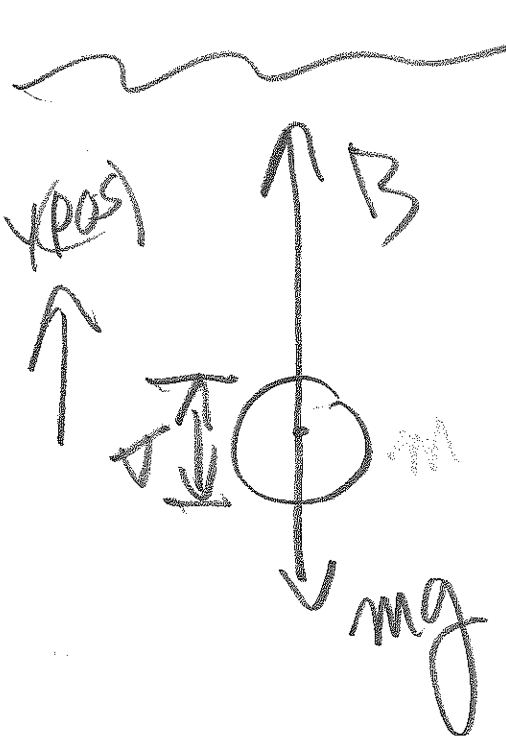
$$m \cdot a = mg - B$$

$$\rho \nabla \cdot a = \rho \nabla \cdot g - \rho_l \cdot \nabla \cdot g$$

$$a = \left(1 - \frac{\rho_l}{\rho}\right) \cdot g$$

$$\frac{\rho_l}{\rho} < 1$$

II. Rising



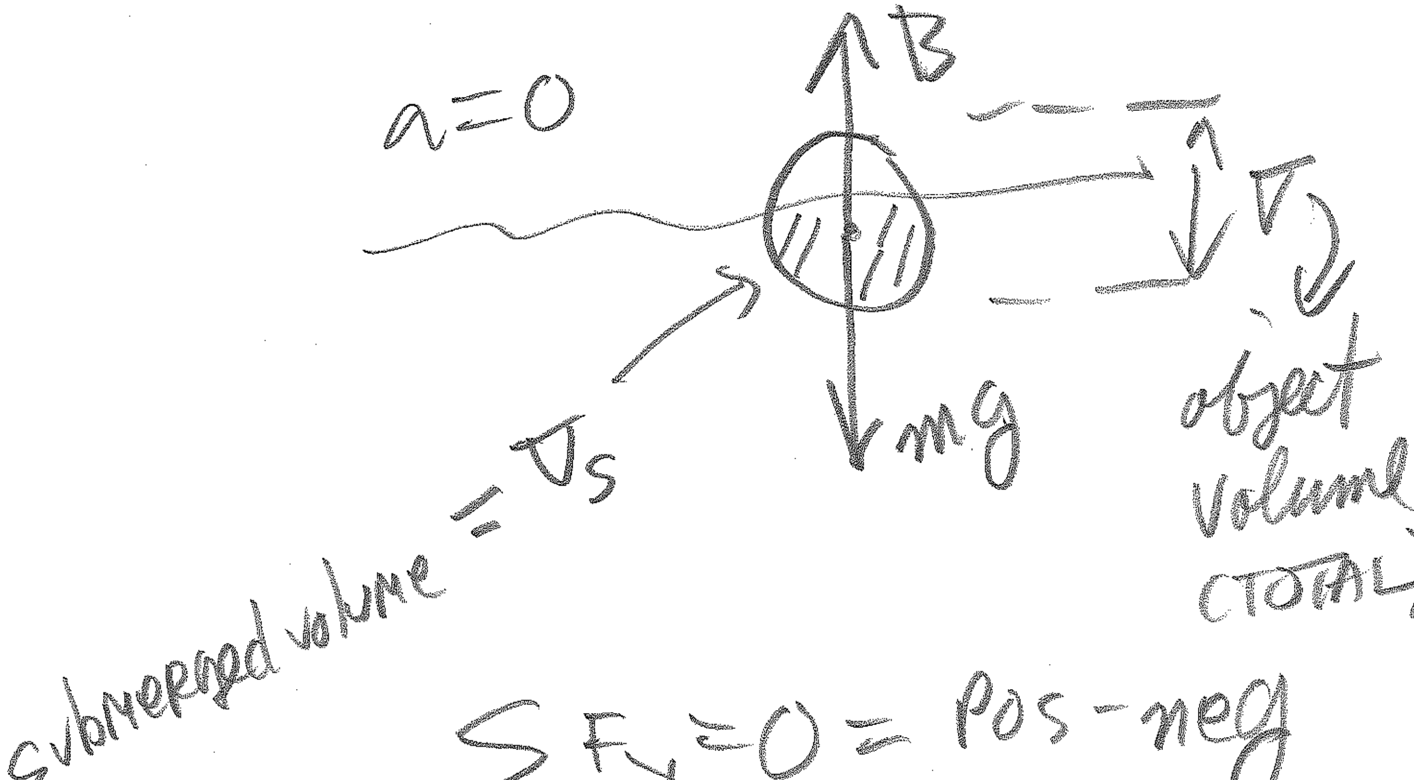
$$\Sigma F_y = ma = B - mg$$

$$\rho \nabla a = \rho_\ell \nabla \cdot g - \rho \nabla \cdot g$$

$$a = \left(\frac{\rho_\ell}{\rho} - 1\right) \cdot g$$

$$\frac{\rho_\ell}{\rho} > 1$$

III Floating



$$\sum F_y = 0 = pos - neg$$

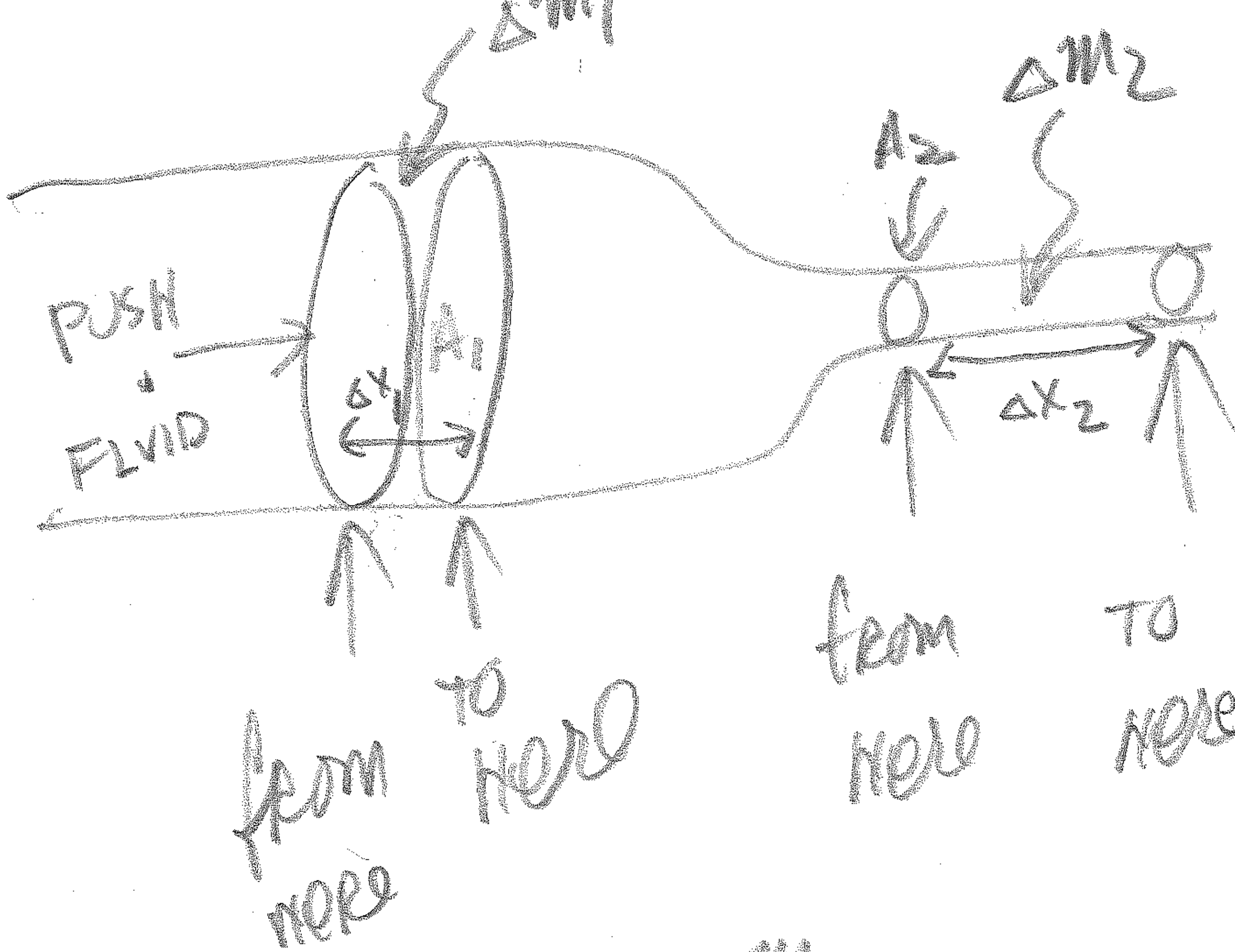
$$0 = B - mg$$

$$B = mg$$

$$\rho_\ell \nabla_s g = \rho \cdot \nabla \cdot g$$

$$\boxed{\frac{\nabla_s}{\nabla} = \frac{\rho}{\rho_\ell} \leq 1}$$

fluid flow 13.5, 13.6



$$\Delta m_1 = \Delta m_2$$

$$\rho_\ell \cdot V_1 = \rho_\ell \cdot V_2$$

$$\rho_\ell \cdot A_1 \cdot \Delta x_1 = \rho_\ell \cdot A_2 \cdot \Delta x_2$$

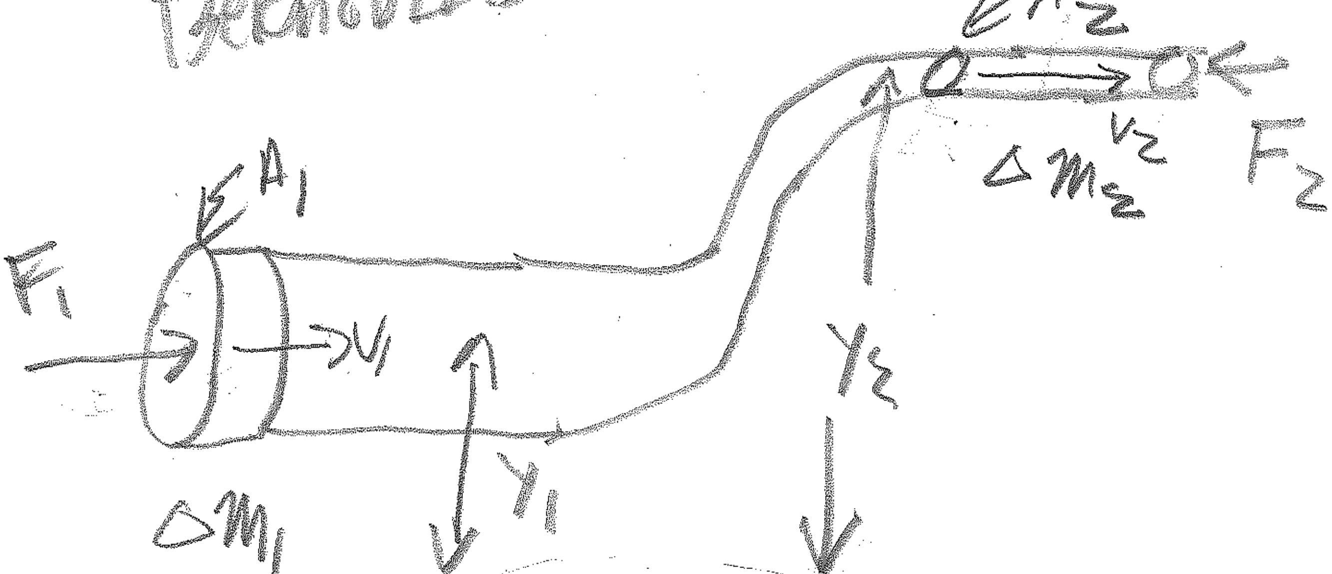
$$\rho \cdot \Delta x_1 \cdot A_1 = \rho \cdot \Delta x_2 \cdot A_2$$

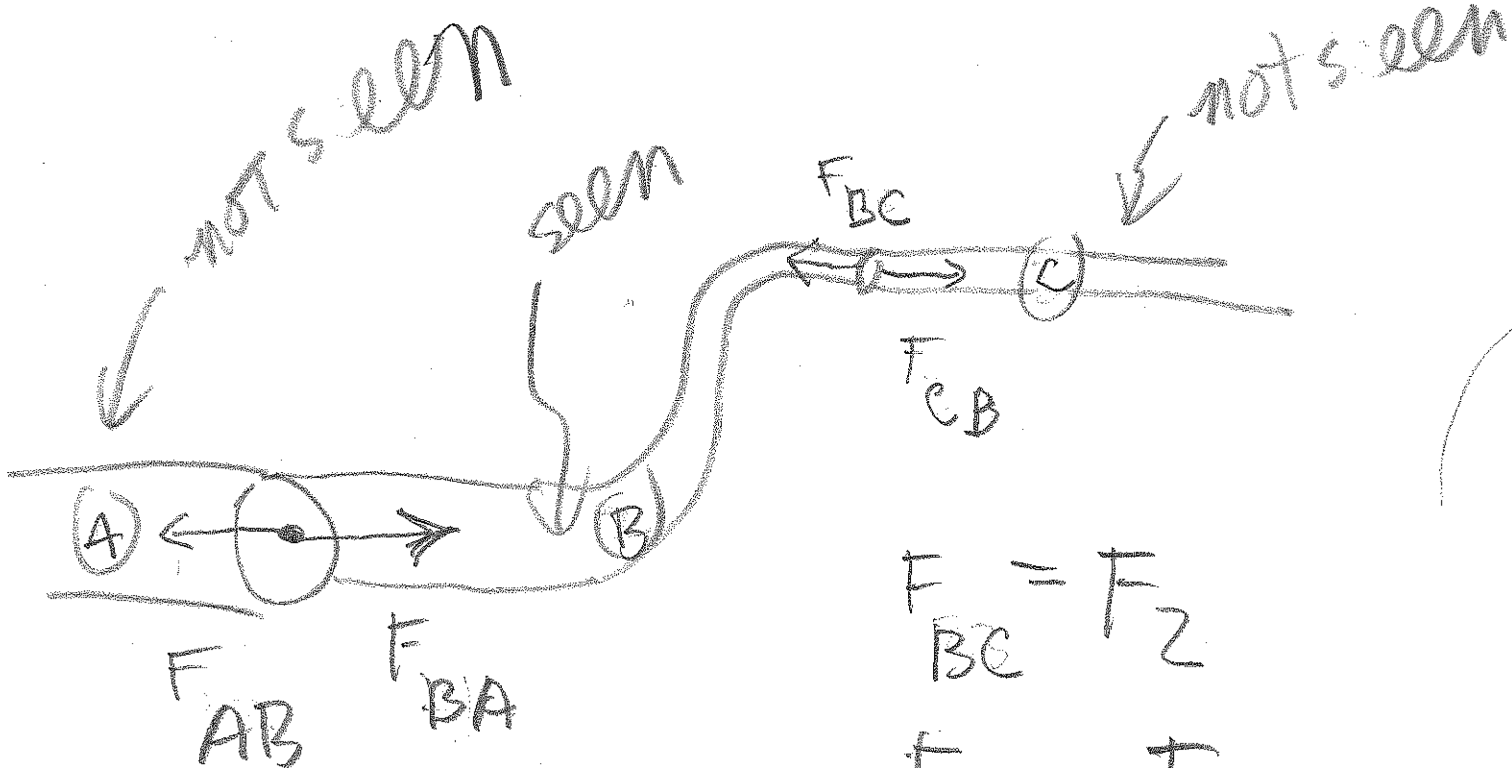
$$\cancel{\rho} \cdot \frac{\Delta x_1}{\Delta t} \cdot A_1 = \cancel{\rho} \cdot \frac{\Delta x_2}{\Delta t} \cdot A_2$$

$$A_1 \cdot V_1 = A_2 V_2$$

$$V_1 = \frac{\Delta x_1}{\Delta t}; \quad V_2 = \frac{\Delta x_2}{\Delta t}$$

BERNOULLI'S EQUATION:





$$F_{BC} = F_2$$

$$F_{BA} = F_1$$

CH 7

$$W_{net} = F_1 \cdot \Delta x_1 - F_2 \cdot \Delta x_2 + \Delta m_1 g y_1 - \Delta m_2 g y_2$$

$$\Delta m_1 = \rho_\ell \bar{V}_1$$

$$= \rho A_1 \cdot \Delta x_1$$

$$\Delta m_2 = \rho_\ell \bar{V}_2$$

$$= \rho_\ell \cdot A_2 \cdot \Delta x_2$$

$$W_{net} = \tfrac{1}{2}\Delta m_2 v_2^2 - \tfrac{1}{2}\Delta m_1 v_1^2$$

and $F_1 = P_1 \cdot A_2$; $F_2 = P_2 A_2$

conclusion: APPLICATIONS Airflight, BLOOD FLOW; STORMS, curve balls

$$\tfrac{1}{2}\rho_\ell v_1^2 + \rho_\ell g y_1 + P_1 = \tfrac{1}{2}\rho_\ell v_2^2 + \rho_\ell g y_2 + P_2$$