8-21-13

(1

CH 4 SUMMARY:

$$F_x = -Kx$$

$$m\frac{d^2x}{dt^2} = -Kx$$

$$x = A\cos(\omega t + \phi)$$

x replaced by θ, ETC.

simple pendulum

TOTAL ENERGY $= \frac{1}{2}KA^2 =$ MAXIMUM P.E. $= U_{MAX}$

$$\frac{1}{2}mv_x^2 + \frac{1}{2}Kx^2 = \text{constant}$$

$$KE + PE = \frac{1}{2}KA^2$$

$$x = A\cos(\omega t + \phi)\ ;\ \omega = \sqrt{\frac{K}{m}}$$

$$m\frac{d^2x}{dt^2} = -Kx$$

2ND ORDER EQN.

2 unknowns; A, ϕ

need $X(0)$ and $\frac{dx}{dt}(0) = V_0 = V(0)$
$= x_0$

Let $X(0)$ and V_0 be known.

$$\frac{1}{2}mV_0^2 + \frac{1}{2}KX_0^2 = \frac{1}{2}KA^2$$

solve for A.

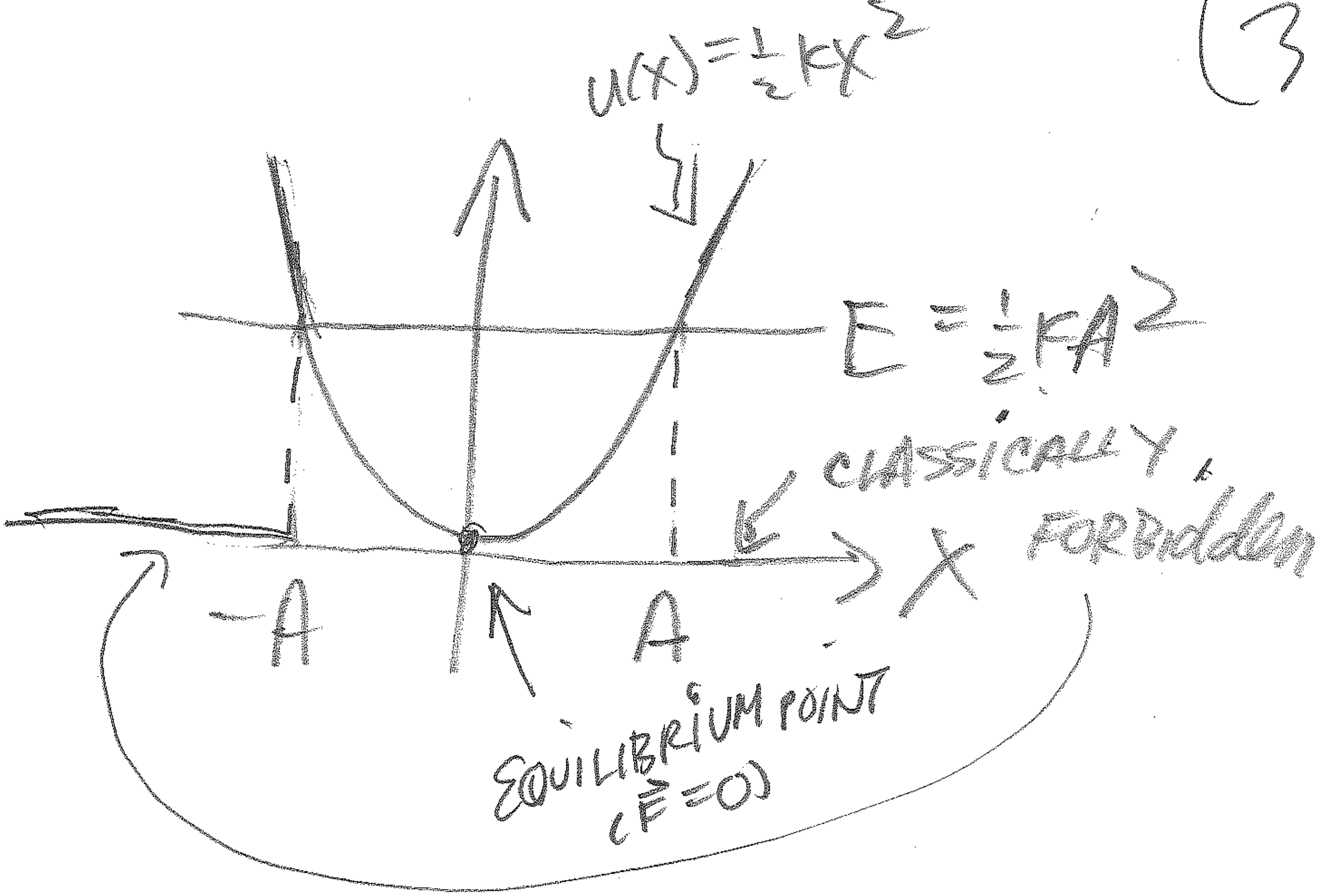
$$X = A\cos(\omega t + \phi)$$

$$X_0 = A\cos\phi$$

$$V_0 = \frac{dx}{dt}\Big|_{t=0} = -\omega A\sin(\omega t + \phi)\Big|_{t=0}$$

$$V_0 = -\omega A\sin\phi_0$$

$$\left.\boxed{\begin{array}{l} X_0 = A\cos\phi \\ V_0 = -\omega A\sin\phi \end{array}}\right\} \text{Find } \phi$$



NOTE: $F_x = -\frac{dU}{dx}$

FORBIDDEN:

$x > A$

$x < -A$,

IF TOTAL ENERGY

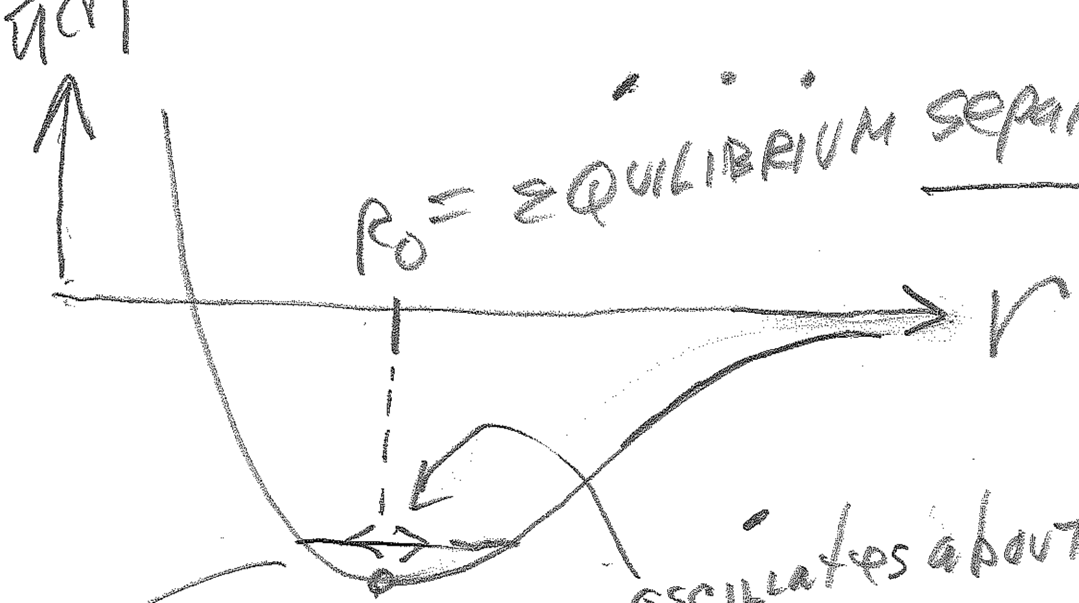
$= \frac{1}{2}kA^2$.

$A = x_{MAX}$

$-A = x_{MIN}$

MOLECULAR VIBRATIONS sec. 14.4

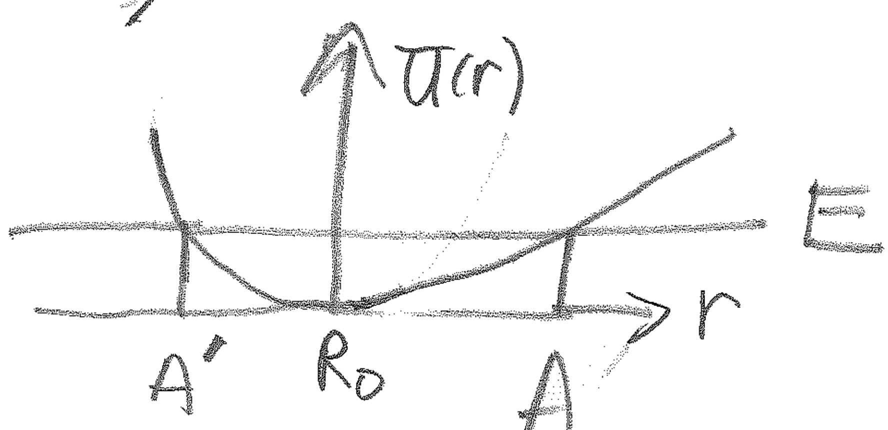
R_0 = EQUILIBRIUM separation.



oscillates about R_0

r = intermolecular separation.

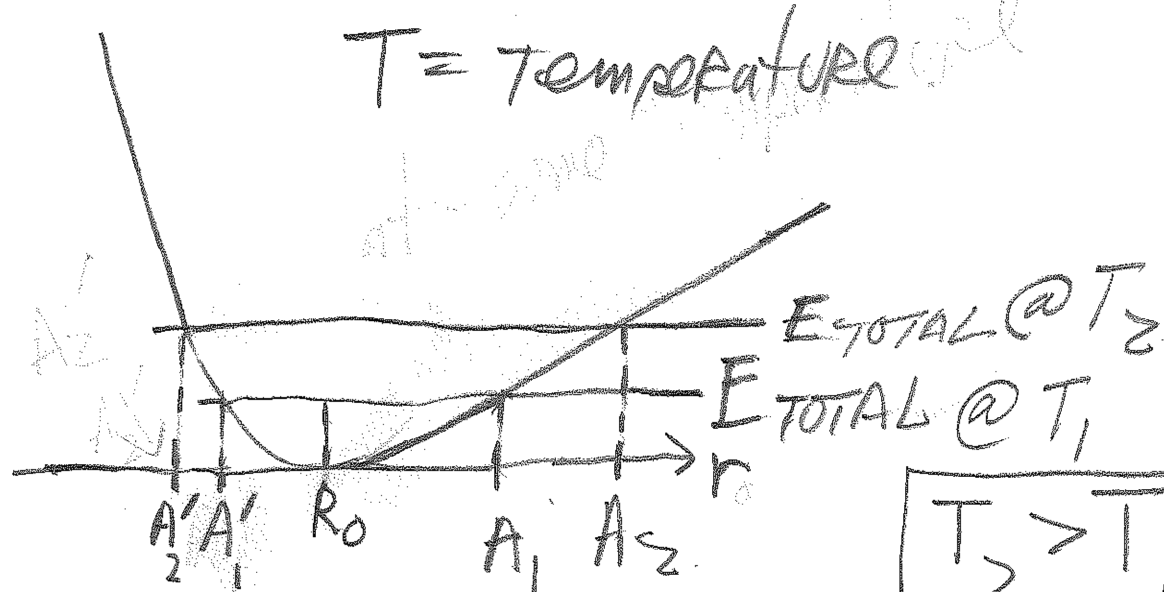
BLOW UP:



Asymmetric oscillation

see sec. 17.4 : THERMAL expansion

T = temperature

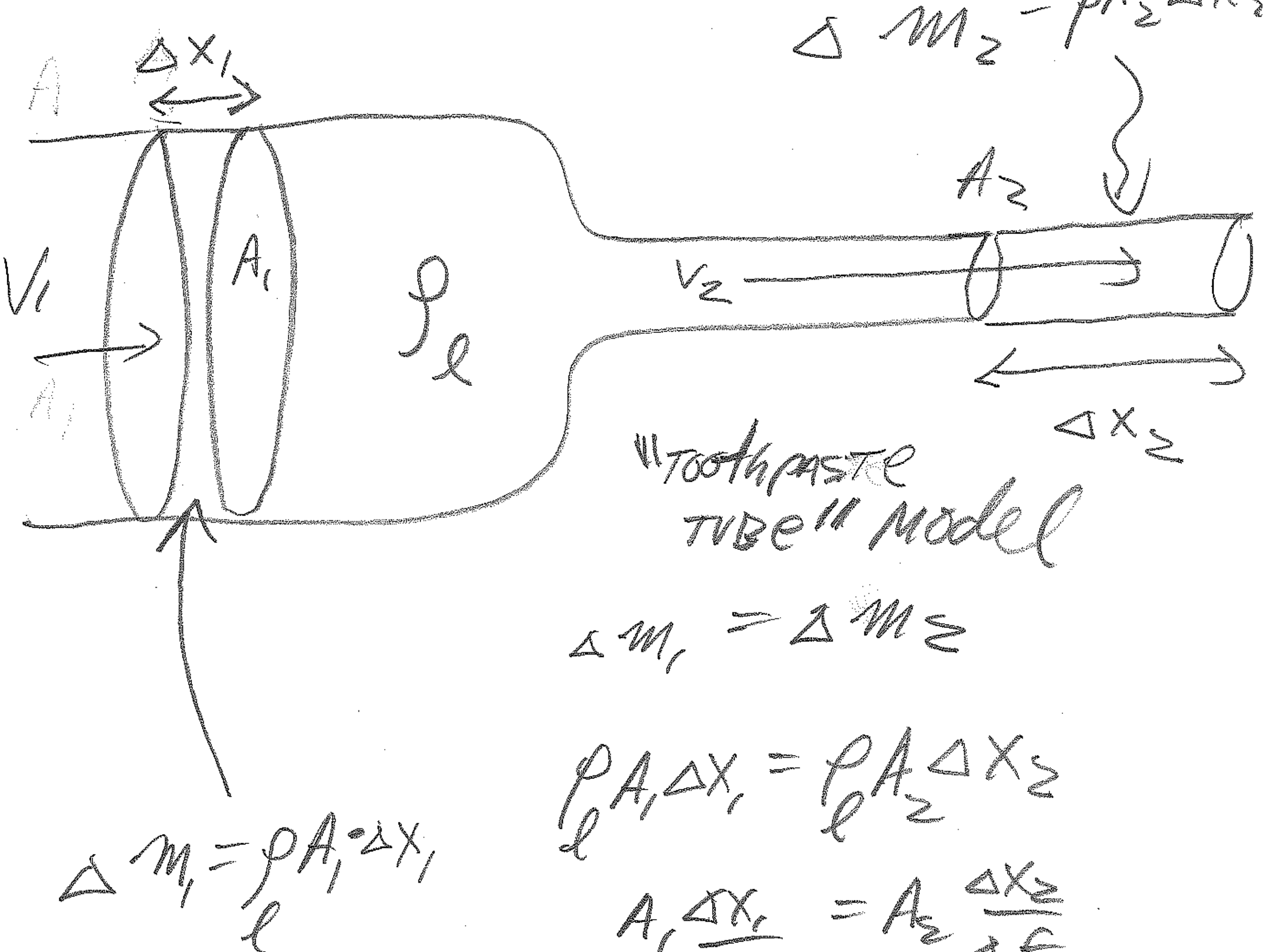


$$\boxed{T_2 > T_1}$$

Asymmetric vibration explains expansion.

Heat up MATERIAL FROM T_1 TO T_2.

12.4 Fluid Flow



"Toothpaste tube" model

$$\Delta m_1 = \Delta m_2$$

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

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

$$\boxed{A_1 v_1 = A_2 v_2}$$

Equation of continuity!

NOTE: fluid is incompressible.
ρ_ℓ = constant throughout pipe

volume flow rate:

$$\frac{dV}{dt} \equiv AV = \text{constant}$$

$A \cdot \Delta X = \text{volume} = V$

$$\text{volume flow rate} = \frac{dV}{dt} = A\frac{dx}{dt}$$

$$= Av$$

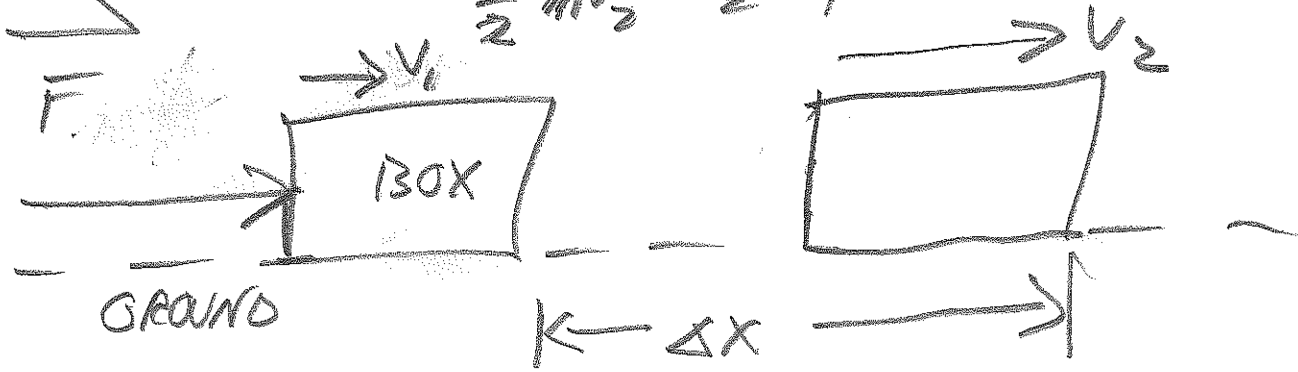
(QED)

BERNOULLI'S LAW: use

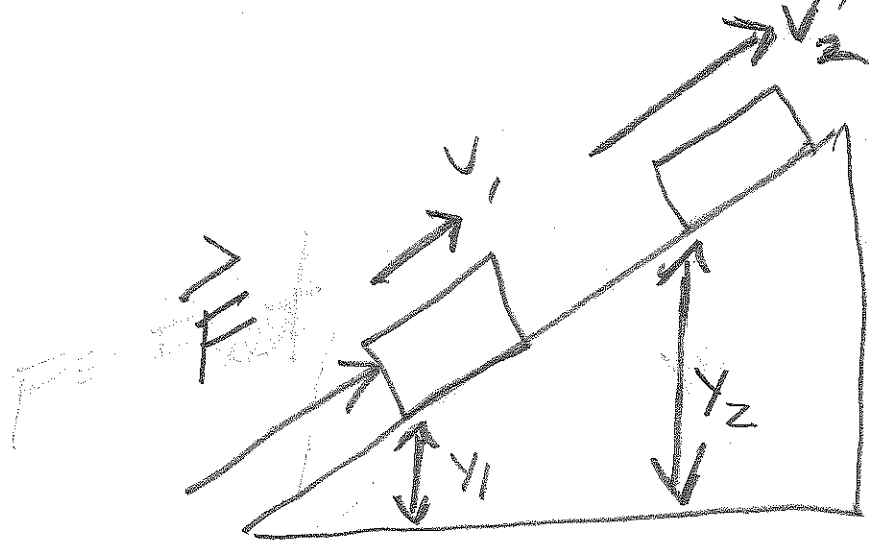
4A WORK ENERGY THEOREM

$\Delta KE = \text{net work}$

$$\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = F \cdot \Delta X$$



with gravity:



$$\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = F\Delta x + mg(y_1 - y_2)$$

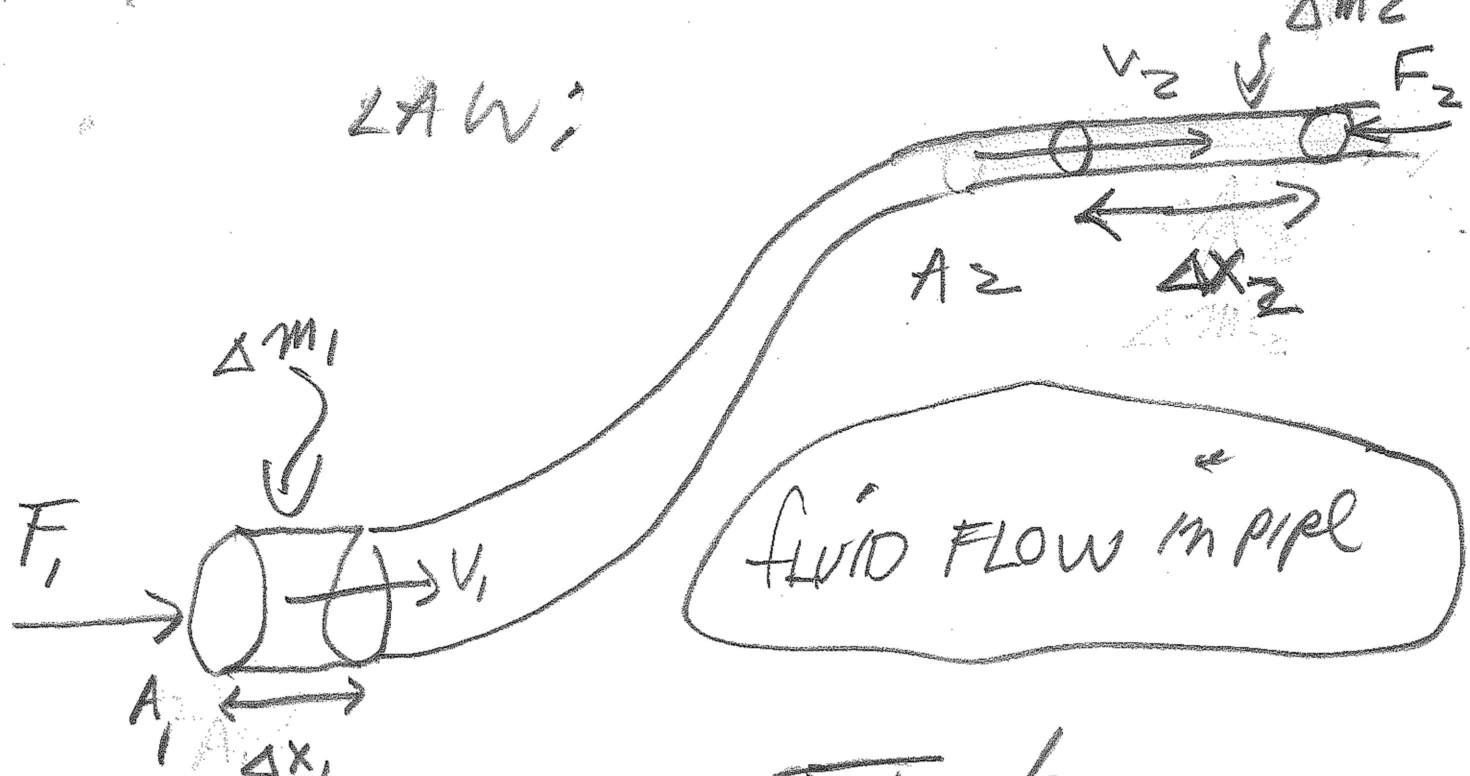
<u>note</u>: $mg(y_1 - y_2) < 0$

$W_g = mg(y_1 - y_2)$: gravity work $= W_g < 0$

Also use conservation of energy

$$\boxed{\frac{1}{2}mv_1^2 + mgy_1 + F\Delta x = \frac{1}{2}mv_2^2 + mgy_2}$$

NOW TURN TO BERNOULLI'S LAW:



$$\Delta KE = W_{net}$$

$$\frac{1}{2}\Delta m_2 v_2^2 - \frac{1}{2}\Delta m_1 v_1^2 = W_g + W_F$$

$$\frac{1}{2}\Delta m_2 v_2^2 - \frac{1}{2}\Delta m_1 v_1^2 = \Delta m_1 g y_1 - \Delta m_2 g y_2 + W_F$$

note: $\Delta m_1 = \Delta m_2 = \Delta m$, FROM conservation of mass (sec. 12.4).

ALSO: W_F = NET APPLIED WORK

$$= \boxed{F_1 \Delta x_1 - F_2 \Delta x_2}$$

THUS:

$$\frac{1}{2}\Delta m V_2^2 - \frac{1}{2}\Delta m V_1^2 = \Delta m g(Y_1 - Y_2) + P_1 \cdot A_1 \Delta X_1 - P_2 \cdot A_2 \Delta X_2$$

NOTE: $\Delta m = \rho_\ell A_1 \cdot \Delta X_1 = \rho_\ell A_2 \Delta X_2$

NOTE: $A_2 \Delta X_2 = A_1 \Delta X_1 = \Delta V$

THUS:

$$\frac{1}{2} \cdot \rho_\ell A_2 \Delta X_2 \cdot V_2^2 - \frac{1}{2}\rho_\ell A_1 \Delta X_1 V_1^2 = \rho_\ell \cdot \Delta V \cdot g(Y_1 - Y_2) + (P_1 - P_2)\Delta V$$

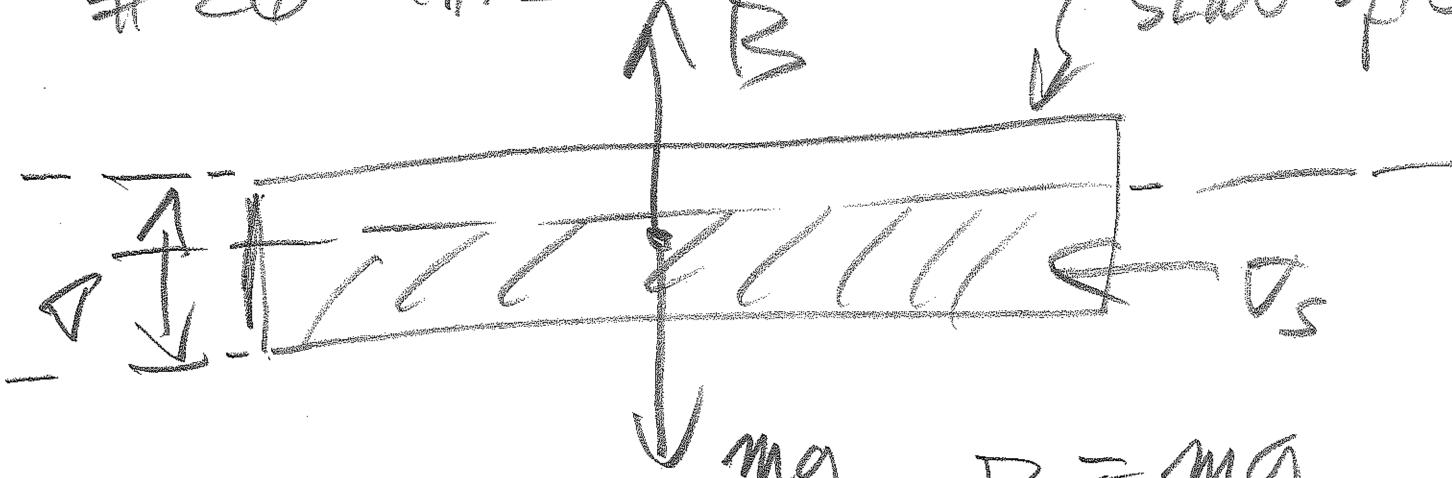
THUS:

$$\frac{1}{2} \cdot \rho_\ell \Delta V V_2^2 - \frac{1}{2}\rho_\ell \Delta V \cdot V_1^2 = \rho_\ell \Delta V \cdot g(Y_1 - Y_2) + (P_1 - P_2)\Delta V$$

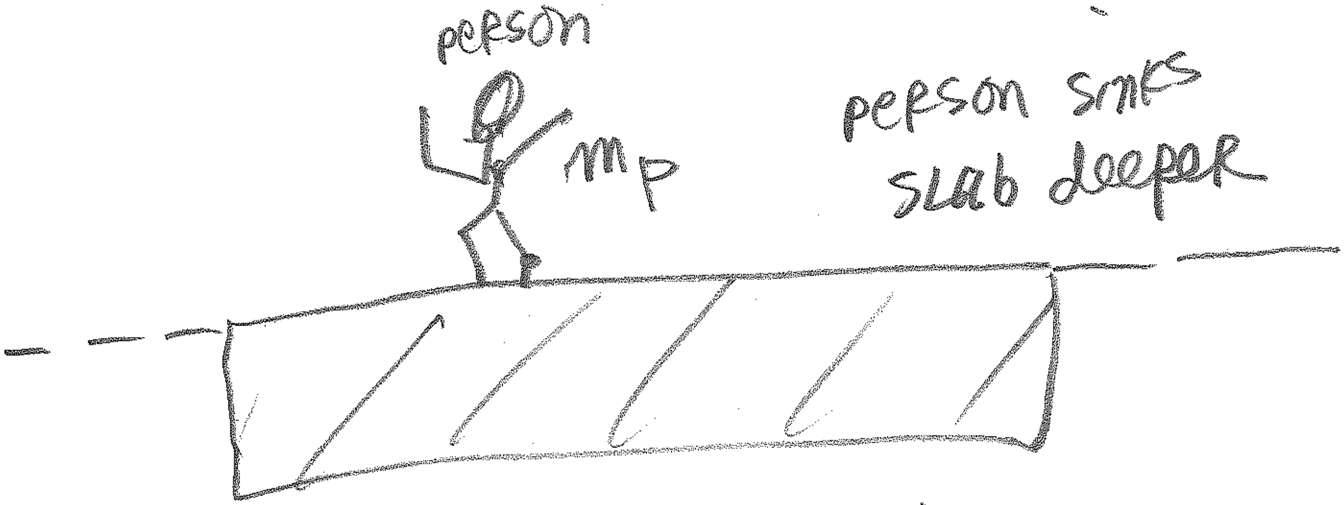
ΔV cancels

$$\Longrightarrow \boxed{\frac{1}{2}\rho_\ell V_2^2 + \rho_\ell g Y_2 + P_2 = \frac{1}{2}\rho_\ell V_1^2 + \rho_\ell g Y_1 + P_1}$$

#26 - CH12 HINT:



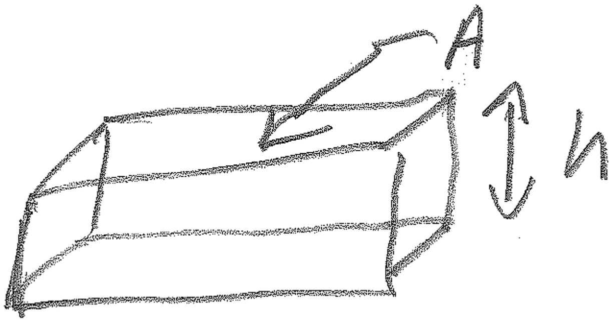
$$B = mg$$



person sinks slab deeper

$$\nabla_s = \nabla \qquad B' = mg + m_p g$$

General Volume formula:



$$\nabla = A \cdot h$$

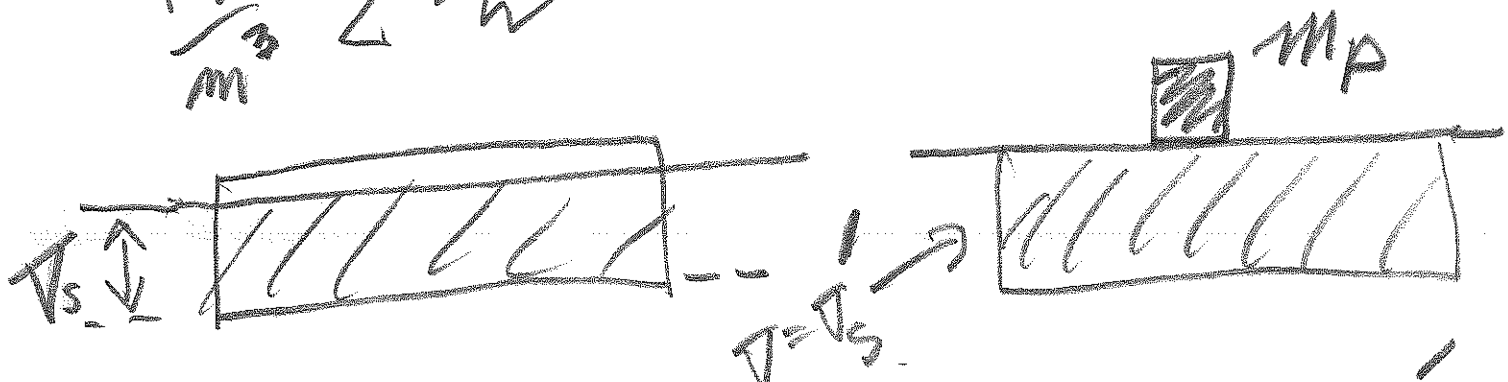
#20 - CH12

IF NO PERSON on ice:

$$B = mg$$

$$\boxed{\frac{\rho_w}{\rho_{ice}} = \frac{V}{V_s}} = \frac{1}{0.92} = 1.086$$

units: $\frac{kg}{m^3}$ $\begin{cases} \rho_{ice} = 0.92 \times 10^3 < \rho_w \\ \rho_w = 1.000 \times 10^3 \end{cases}$



$$m_p g + mg = B'$$

$$\rho_{ice} \cdot V \cdot g = \rho_w \cdot V_s \cdot g \iff m_p g + \rho_{ice} V \cdot g = \rho_w V \cdot g$$

$V_s < V$ FIND V.

$\boxed{V_s = 0.92 V}$ → $V - V_s$ = difference

26 CH12

$$\text{Difference} = \bar{V} - 0.92\bar{V} =$$

$$= \bar{V}_S' - \bar{V}_S$$

$$\downarrow$$

$$\bar{V} - 0.92\bar{V} = \boxed{0.08\bar{V}}$$