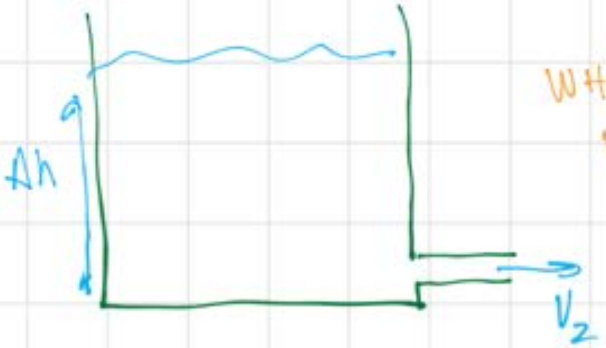
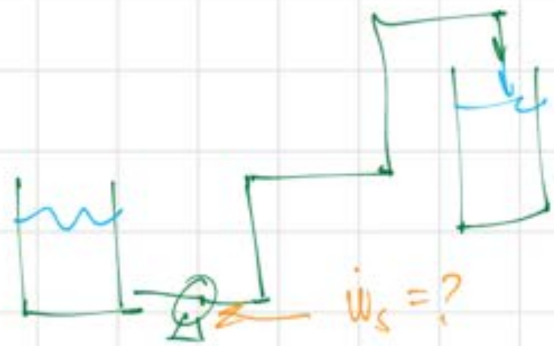
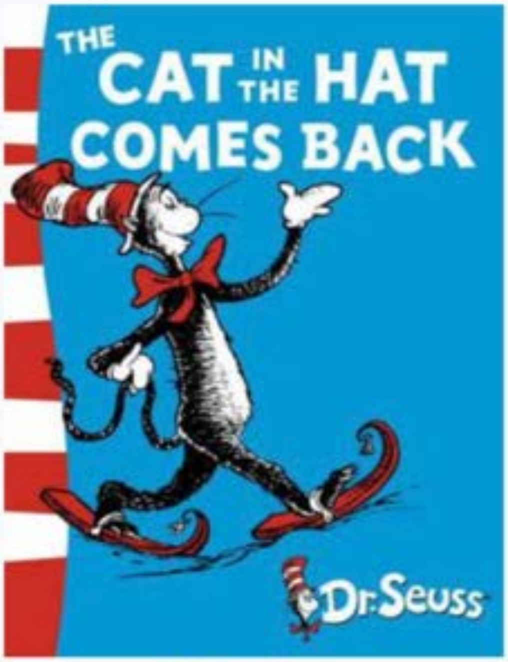
CBE 30357
11/21/17

RECALL FROM LAST WEEK...





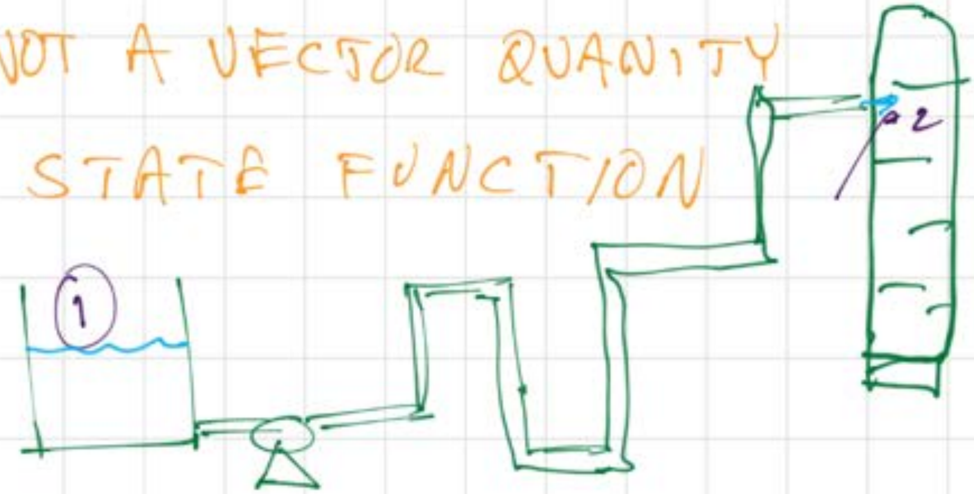
MOMENTUM EQUATION
OF NO USE ...



Author Dr. Seuss

WE NEED
CAT "Z" !!

- NOT A VECTOR QUANITY
- STATE FUNCTION



COULD CONSIDER CHANGE FROM STATE (1) → (2)

FOR PIPE FLOW

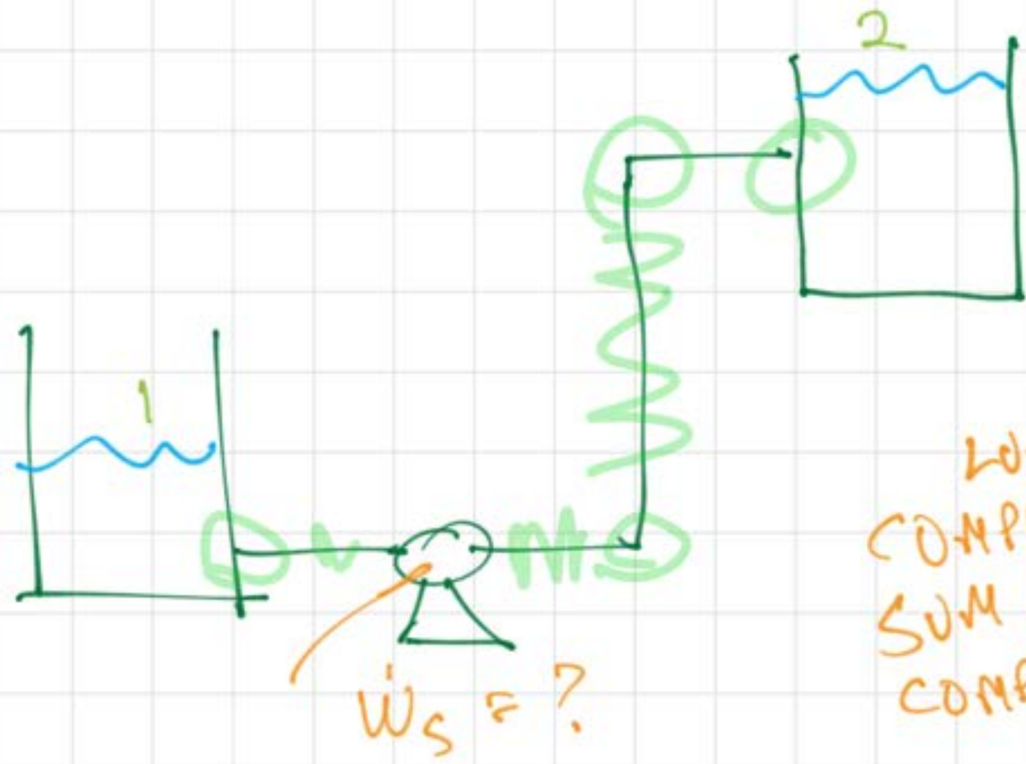
$$l_v = \frac{2 L f v^2}{D}$$

MORE GENERALLY ...

$$l_v = \frac{1}{2} K v^2$$ TABLES

FOR MULTIPLE FITTINGS AND PIPE SEGMENTS...

$$l_v = \sum_i \frac{1}{2} K_i v_i^2$$



LOSSES COMPRISED OF SUM OF INDIVIDUAL COMPONENTS

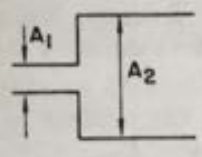
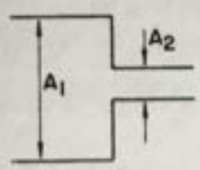
$$(gh_2 - gh_1) = \delta W_s - \sum_i l_{v_i}$$

$$\dot{W}_s = \dot{m} g(h_2 - h_1) + \dot{m} \sum_i l_{v_i}$$

$$\sum_i l_{v_i} =$$ 2 ELBOWS + 1 EXIT + 1 ENTRANCE + 4 STRAIGHT PIECES OF PIPE ...

TABLE 5-1

LOSSES IN FITTINGS AND VALVES FOR TURBULENT FLOW[a]

Fitting or valve	*Velocity heads lost, K_f*
90° elbow, standard	0.75
90° elbow, square	1.3
Coupling	0.04
Gate valve	
Open	0.17
Half-open	4.5
Globe valve, bevel seat	
Open	6.4
Half-open	9.5
Sudden expansion 	$\left(\frac{A_2}{A_1} - 1\right)^2$
Sudden contraction 	$\left(\frac{2}{m} - \frac{A_2}{A_1} - 1\right)^2$ m is the root of the quadratic $\frac{1 - m(A_2/A_1)}{1 - (A_2/A_1)^2} = \left(\frac{m}{1.2}\right)^2$
Rounded entrance	0.05

[a]The result for the sudden expansion is derived in Sec. 6.2. The result for the sudden contraction is from Martin, *Chem. Eng. Educ.*, Summer 1974, p. 138. Other values are from *Perry's Handbook*.

Example 5.7

A liquid is pumped through a 50-mm-diameter smooth pipe between two tanks at a rate of 3 kg/s in the section of the process stream shown in Fig. 5-5. The liquid has properties $\rho = 10^3$ kg/m^3, $\eta = 10^{-3}$ Pa·s. The pressure above the

$$\Delta P = \tfrac{1}{2}\rho K V^2$$

↑ DOWNSTREAM VELOCITY