Name (2 points): Dawson

January 20, 2016
ChBE 3200
Quiz 1

Make the following assumptions when necessary:

$\rho_{water} = 1000\ kg\ m^3$
$g = 10\ m/s^2$
$P_{atm} = 1\ atm = 760\ mm\ Hg = 1.01 \times 10^5\ Pa = 14.7\ psi$ $\quad Pa = \frac{N}{m^2}$

Question 1 (2 points):
What is the **absolute pressure** of sea water a distance of 200 m below the water surface?

A) 2.0×10^6 Pa
B) 2.1×10^6 Pa
C) 0.2×10^6 Pa
D) 0.1×10^6 Pa
E) None of the above

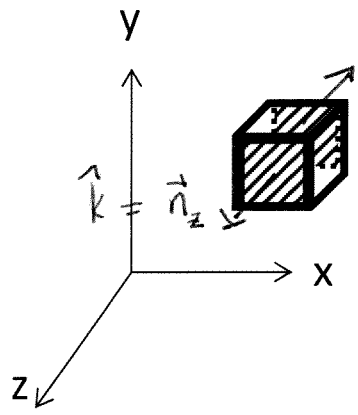
ABS. Pressure = GAGE Pressure + P_{atm}

$$P_{Ab} = \rho g h + P_{atm}$$

$$P_{Ab} = \left(1000 \frac{kg}{m^3}\right)\left(10 \frac{m}{s^2}\right)(200m) + 1.01 \times 10^5 \frac{N}{m^2}$$

$$P_{Ab} = 2 \times 10^6 \frac{N}{m^2} + 0.1 \times 10^6 \frac{N}{m^2}$$

Question 2 (4 points):
Given **cubic fluid element** in **3D coordinate system shown below**, identify the components of the Cauchy Stress tensor that apply to the **front and back surfaces** of the cube (**highlighted by patterned squares**). Note: tell me which apply in terms of **a-i in the matrix** and define as we did in class in terms of **type of stress and the direction**



area defined by norm vector $\hat{k}$

Cauchy Stress Tensor

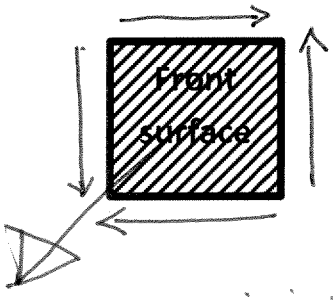
$$\begin{matrix} i \\ j \\ k \end{matrix}\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}$$

$g = \tau_{ki}$ shear stress

$h = \tau_{kj}$ shear stress

$i = \tau_{kk} \Rightarrow \sigma_{kk}$ normal stress

Question 3 (2 points):
The **front surface** of the cubic element above is shown below. For this surface draw the **force vectors** that contribute to the **stresses that you listed above** and define the stresses in terms of these forces and the appropriate area.



$\vec{F}_i$ results in τ_{ki} \ parallel forces

$\vec{F}_j$ results in τ_{kj} /

$\vec{F}_k$ results in σ_{kk} → perpendicular forces

$i, j, k \rightarrow x, y, z$ OK! $F_{i,i} \Rightarrow F_{\parallel}$ drawn correctly