GEORGIA INSTITUTE OF TECHNOLOGY

COLLEGE OF ENGINEERING

BMED3300 - BIOTRANSPORT

QUIZ 2 (SPRING 2014) - ETHIER

STUDENT NAME: Solution

GTID NUMBER: _____

RECITATION SECTION: _____

(Section E is Wednesdays at 2 pm; Section F is Wednesdays at 1 pm)

Closed book
All non-communicating calculator types allowed
Time allotted: 15 minutes
Do all work in this booklet

Reminder: for questions requiring numerical answers, units are <u>required</u> and worth 50%

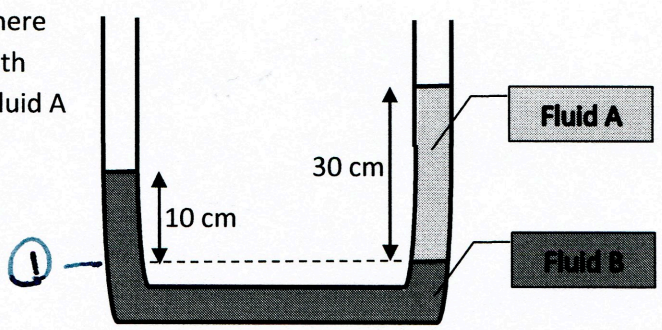
Question	Maximum Mark	Actual Mark
1	6	
2	6	
Total	**12**	

Maximum possible marks are 12. However, the quiz will be marked out of 10, i.e. if you get 8/12, that is equivalent to 80%.

Hydrostatic pressure in an incompressible fluid: $p = p_0 + \rho g h$

Archimedes' principle: $F_b = \rho g V_{disp}$

1. A U-shaped tube is open to the atmosphere on both sides. It is filled with 2 fluids, with the dimensions shown. The density of fluid A is $\rho_A = 900\ kg/m^3$. What is ρ_B?



Do your GIM analysis here

- This is hydrostatics (1).
- Same pressure p_0 on free surfaces (1) and at level (1) (1)
- Incompressible

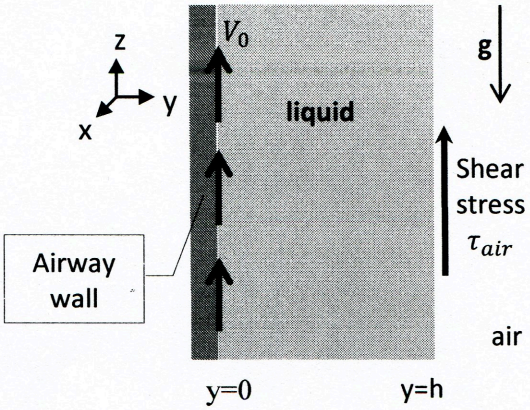
$P_1 = P_0 + \rho_B g h_B$ $\quad h_B = 10\ cm$ (1)

$P_1 = P_0 + \rho_A g h_A$ $\quad h_A = 30\ cm$ (1)

$\therefore \rho_B h_B = \rho_A h_A$

$\rho_B = \rho_A \frac{h_A}{h_B} = 900 \frac{kg}{m^3} (3) = 2700 \frac{kg}{m^3}$ (1)

2. The airways of a patient's lung are coated with a thin liquid lining of highly viscous fluid. In the larger airways, cilia on the airway wall beat up and down "pumping" the fluid upward (toward the mouth). We model this process by assuming that the velocity of the fluid at the airway wall is a known value, V_0. Here we wish to consider the situation at the instant that the patient is coughing. This creates an extremely fast upwards flow of air, which in turn creates a non-zero shear stress τ_{air} as shown. We must also account for gravity.

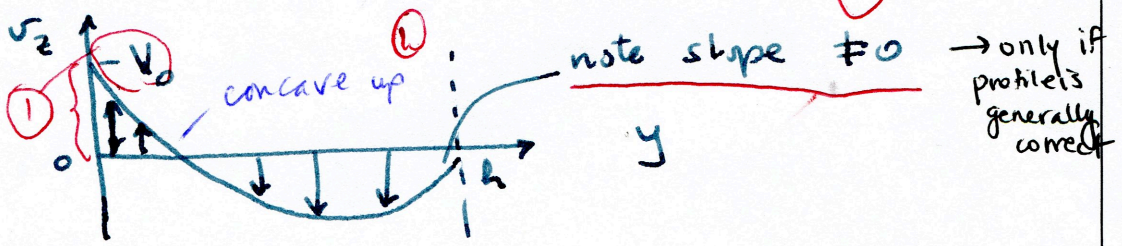


a. Carefully draw the velocity profile $v(y)$ of the fluid flow in the liquid lining. Point out relevant features.
b. What physical principle(s) would you use to solve this problem?
c. Describe in words the forces that will affect the flow of liquid in this situation.

Note that you do not need to solve the problem; you only need to answer the questions above.

Do your GIM analysis here (parts a-d)

(a) $v_x = v_y = 0$. v_z shown below.



note slope $\neq 0$ → only if profile is generally correct

(b) Conservation of mass + momentum balance (continuity + Navier-Stokes)

(c)
- gravity will pull fluid down
- friction between air & liquid will cause ~~fluid~~ liquid to tend to move up; "moving" wall will also cause liquid to move up.
- viscosity will distribute frictional forces throughout liquid.

need all 3