GEORGIA INSTITUTE OF TECHNOLOGY

COLLEGE OF ENGINEERING

BMED3300 - BIOTRANSPORT

QUIZ 2 (SPRING 2014) – KEMP

STUDENT NAME: Solution

GTID NUMBER: ______________________

RECITATION SECTION: ______________________

(Section A is Wednesdays at 12 noon; Section B is Wednesdays at 10 am)

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 required and worth 50%

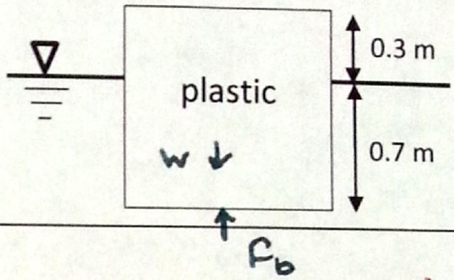
Question	Maximum Mark	Actual Mark
1	6	
2	6	
Total	**12**	

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 solid cube of plastic (dimensions 1 m x 1 m x 1m) floats in water. The density of the water is 10^3 kg/m^3 and 0.3 m of block is above the surface of the water. What is the density of the plastic cube?



Do your GIM analysis here

- There will be a buoyant force on cube, plus the weight of the cube 1
- Steady
- Use Archimedes' principle 1
- System is cube

$W = \rho_c L^3 g$ 1 $\quad L =$ side length $= 1$ m

$\rho_c =$ density of cube

$F_b = \rho_w L^2 h g$ 1 $\quad h = 0.7$m

$\rho_w =$ density of water

Need to have correct ρ's for marks

At equilibrium, $W = F_b$ 1

$\therefore \rho_c L^3 g = \rho_w L^2 h g$

$\rho_c = \frac{h}{L} \rho_w = (0.7)(1000 \frac{kg}{m^3}) = 700 \frac{kg}{m^3}$ 1

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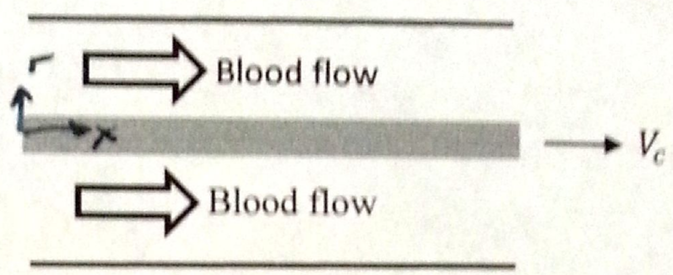
2. Consider a cylindrical catheter of radius ϵR that is placed in a blood vessel of radius R. Assume that the catheter is concentric with the centerline of the blood vessel. **The catheter is being inserted into the artery and so is moving left to right at speed V_c.** We wish to determine the change in flow rate relative to a vessel of the same radius without a catheter. Assume steady flow and that the pressure drop is the same with and without the catheter.



a. What co-ordinate system would you use to solve this problem?
b. What physical principle(s) would you use to solve this problem?
c. What boundary condition(s) could you apply, given that the catheter is moving in this problem?
d. Describe in words the forces that will affect the flow of blood in this vessel.

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) cylindrical co-ordinates centered on catheter (see diagram) 1

(b) conservation of mass + momentum balance (continuity + N-S eqn's) [need both] 1

(c) No slip: $v_x(r=\epsilon R) = V_c$ 2

$v_x(r=R) = 0.$

(d) · pressure gradient driving the flow

· friction due to vessel wall & catheter surface, transmitted through blood by viscosity. 2

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