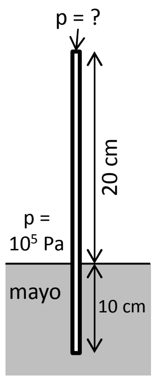
NAME: ________________________ STUDENT #___________

AESB2320, 2016-17
Part 1 Re-Examination - 30 June

Write your solutions *on your answer sheet*, not here. In all cases ***show your work***.
To avoid any possible confusion,
state the equation numbers and figure numbers of equations and figures you use
along with the text you are using (BSL1, BSL2 or BSLK).
Beware of unnecessary information in the problem statement.

1. Rocky recalls seeing that photo in class of a student trying to suck peanut butter up a straw, and decides to try it out. He doesn't have any peanut butter in his kitchen, but he does have mayonnaise, which has a density of 910 kg/m^3; it is a Bingham plastic with yield stress τ_o = 100 Pa and plastic viscosity μ_o = 0.03 Pa s. His straw has 4 mm inner diameter and is filled with mayonnaise. The bottom of the straw extends 10 cm below the surface of the mayonnaise in the jar, and the top is 20 cm above the surface of the mayonnaise. The air pressure just above the level of the mayonnaise in the jar is 1 atmosphere, i.e. 10^5 Pa. What pressure must he apply at the top of the straw to cause mayonnaise to flow through the straw?
(25 points)



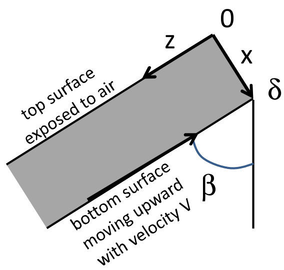
2. A turbidite geological formation is formed by particles settling in water offshore.
   a. Suppose a single spherical sand grain of density 2500 kg/m^3, diameter 0.1 mm, is settling at steady velocity through stagnant water (density 1000 kg/m^3, viscosity 0.001 Pa s). What is the particle's velocity? (20 points)
   b. Suppose another particle has the same density but diameter 0.05 mm. What is its steady-state velocity? (5 points) (don't do this part unless you have time)

   (The settling of clouds of particles in a turbidite is more complicated than this, but answer the question as though the particles were isolated, settling in still water.)
   (total 25 points)

3. A film of Newtonian fluid flows down an inclined plane that is moving upwards with velocity V as shown. (Because the z axis points down, V < 0 on the bottom surface). Viscosity is not constant for this fluid, however, but varies with position according to
   $\mu = [C_1 + C_2\, x]$
   where C_1 and C_2 are constants greater than zero. What is the *last* equation in the derivation in BSL1 Section 2.2 that can be applied directly to this problem? The relevant pages of BSL1 Section 2.2 are appended to this exam. Write that equation number *on your answer sheet*, as

   BSL1 Eq. 2.2-_____

   (10 points)



4. Rocky wants to design a toy gun to shoot water as high as possible. He can pressurize a water tank to 2 x 10^5 Pa. There is an abrupt constriction in the tank, and then a tube of length 20 cm, diameter 5 mm (to direct the water flow). The tube has height of protuberances k = 0.02 mm. Pressure at the outlet of the tube is 10^5 Pa. Water has density 1000 kg/m^3 and viscosity 0.001 Pa s.
   a. What is the velocity of water leaving the tube? (35 points)
   b. To increase the velocity of the water, should Rocky make the tube narrower, or wider? Justify your answer using the tools of this course. (5 points)

   (40 points)