NAME: _____ STUDENT #_____

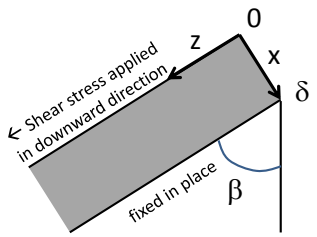
TN4780ta and AESB2320, 2014-15
Part 1 Re-Examination - 25 June

This exam can count toward the Part 1 score for either TN4780ta or AESB2320.
Circle here which course you wish the exam to count toward:

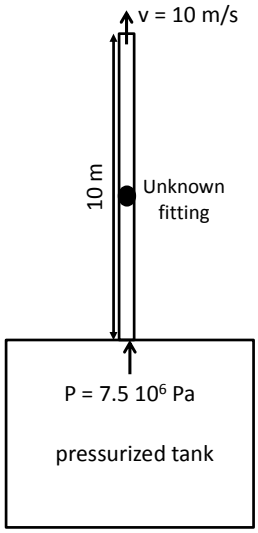
AESB2320 TN4780ta

Turn in this exam with your answer sheet.
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.
Beware of unnecessary information in the problem statement.

1. A Bingham with parameters μ_o and τ_o and density ρ is held between two parallel plates, a distance δ apart, held at an angle β to the vertical as shown. Derive a formula for the minimum shear stress that must be applied to the top plate to cause the Bingham plastic to shear, i.e. to allow the top plate to move. Note: you are not asked to solve for the velocity profile.
(20 points)



2. A large pressurized tank expels water through 10 m of vertical pipe of 2 cm inner diameter. The height of protuberances on the pipe is 0.008 cm. The pipe also contains a fitting or valve for which the friction-loss factor is not known. Just upstream of the pipe entrance, water pressure is 7.5 x 10^6 Pa. At the outlet, pressure is atmospheric, i.e. 10^5 Pa. Water exits the pipe at a velocity of 10 m/s. What is the friction-loss factor for this fitting?
(40 points)



properties of water
μ = 0.001 Pa s ρ = 1000 kg/m^3

3. A scientific article in a medical journal (P. Barss, "Injuries Due to Falling Coconuts," in *Trauma and Acute Care Surgery*) notes that falling coconuts sometimes cause serious injuries to those on whom they fall. Suppose a coconut weighs 1 kg and has diameter 13 cm. What is the terminal velocity of this coconut in air?
(25 points)

properties of air
μ = 1.75x10^{-5} Pa s ρ = 1.26 kg/m^3

4. An engineer pumps a liquid through a cylindrical pipe of length L at a volumetric flow rate Q_1 and measures a pressure difference between inlet and outlet Δp_1. (Note this is *pressure* difference, not potential difference.) She then pumps at a rate $(2Q_1)$, and the pressure difference is less than $(2\Delta p_1)$. Which of the following are possible explanations for this observation? There may be more than one correct answer; indicate all correct answers ***on your answer sheet***. The answer could be one, more than one, or none of the following.
   a. The fluid is a Newtonian fluid in laminar flow. The pipe is horizontal.
   b. The fluid is a Newtonian fluid in highly turbulent flow. The pipe is horizontal.
   c. The fluid is a Bingham plastic in laminar flow. The pipe is horizontal.
   d. The fluid is a shear-thinning power-law fluid in laminar flow. The pipe is horizontal.
   e. The fluid is a shear-thickening power-law fluid in laminar flow. The pipe is horizontal.
   f. The fluid is a Newtonian fluid in laminar flow. The pipe is vertical, with the outlet higher than the inlet.
   g. The fluid is a Newtonian fluid in laminar flow. The pipe is vertical, with the outlet lower than the inlet.

   (15 points)