Name: ____CM Box: ___________

Circle your section:

Lui – 01 Lui – 02 Mech – 07

ES 202
Fluid & Thermal Systems

Examination II
January 31, 2007

Problem	Score
1	/ 18
2	/ 22
3	/ 60
Total	/100

Clearly show all work for credit.

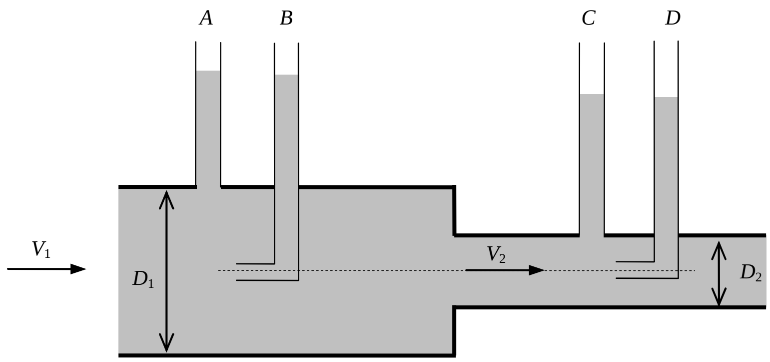
One side of an 8.5” x 11” equation sheet is allowed.
Laptops allowed
No EES allowed

Please hand in your equation sheet with your exam.

Density of water at standard conditions is assumed to be 1000 kg/m^3 in this exam.

Problem 1 (18 points)

Consider the apparatus shown below. In each case consider the flow to be INCOMPRESSIBLE.



(a) Which of the probes measure stagnation pressure?

(b) Which pair of probes indicates the effect of losses?

(c) If the flow is frictionless, which pair of probes indicates a change in velocity?

(d) Assume there are no losses. How do the velocities relate when $D_2 = ½ D_1$? [Circle the correct value.]

$V_1 = ½ V_2$ $V_2 = ½ V_1$

$V_1 = ¼ V_2$ $V_2 = ¼ V_1$

None of the above

(e) This time losses exist. How do the velocities relate when $D_2 = ½ D_1$? [Circle the correct value.]

$V_1 = ½ V_2$ $V_2 = ½ V_1$

$V_1 = ¼ V_2$ $V_2 = ¼ V_1$

None of the above

(f) What condition could replace the streamline restriction when using Bernoulli's equation.

Problem 2 (22 points)

On a rainy day, a friend of yours carefully observes the rain drop motion and proposes a rough estimate of 5 m/s for the terminal speed of the rain drop.

You may assume an average rain drop to be a 2-mm diameter sphere and take the density and dynamic viscosity of air to be 1.184 kg/m^3 and 1.85×10^{-5} kg/m-s, respectively. The volume of the sphere is 4.2×10^{-9} m^3.

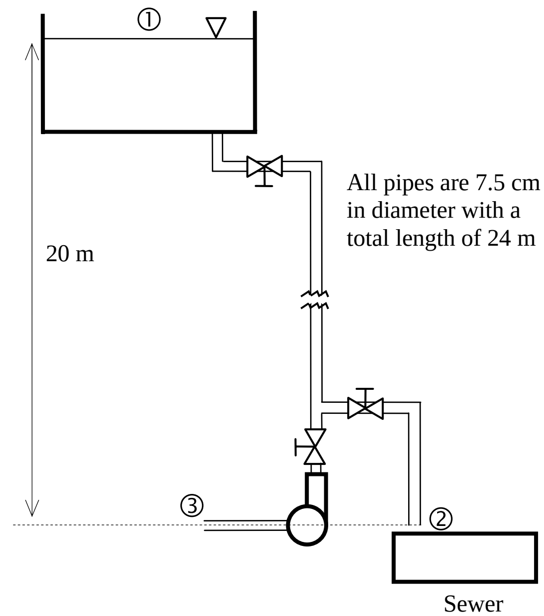
Do you agree with his assessment? Show the logic of your argument for FULL CREDIT.

Problem 3 (60 points)

The new Terre Haute Hilton will have a swimming pool on the top floor. The piping for filling and draining the pool is indicated in the diagram at the right.

All piping is commercial steel and have an inner diameter of 7.5 cm. Each route is 24 m long with a elevation difference of 20 m when the pool is full and 17 m when the pool is empty. All fittings are smooth and flanged. All valves are either fully-open or fully-closed (as appropriate) gate valves. The opening in the pool bottom is sharp.

Use the following properties for water: ρ = 1000 kg/m^3, μ = 1.0 x 10^{-3} kg/(m-s) and ν = 1.0 x 10^{-6} m^2/s. The water main has a supply pressure of 300 kPa and the sewer is at atmospheric presure (100 kPa).



(a) The pool **empties** into a sewer via piping from Point 1 to Point 2. Determine the maximum velocity and volumetric flow rate that could occur. Assume the flow is frictionless.

(b) The pool is **filled** from a city water main via piping from Point 3 to Point 1. A pump is necessary because of the losses and the elevation change. The flow velocity during filling is 4 m/s. Evaluate the following just before the pool is full.

(1) Determine the head loss during filling.

(2) Determine the pump work (per kg of water) required during filling. Assume an ideal pump.

(c) Consider the following changes to the problem.

(1) What would happen to the <u>losses</u> if the pipe material was changed to galvanized iron?

increase decrease stay the same insufficient info

(2) What would happen to the <u>losses</u> if the velocity was increased to 8 m/s?

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