ES 202 - Exam II Spring 1999-2000 Richards

Name:____ Campus Mail Box ____________

Problem 1 (29)__________

Problem 2 (29)__________

Problem 3 (42)__________

TOTAL (100) __________

General Comments

(1) Anytime you apply conservation or accounting principles in solving a problem, sketch and clearly identify the system you have selected. In addition, clearly indicate how your assumptions or given information simplifies the general equations. Numbered-symbols, e.g. P_1 ,in equations must make sense for the problem in question, i.e. they must match you figure and communicate information accurately.

(2) Closed book/notes; however, you may use any of the following:
- ... yellow equation pages provided by instructor
- ... unit conversion page
- ... material in Appendices and end flaps of Wark/Richards text
- ... your equation page (single side of 8-1/2 x 11 sheet of paper)

(3) For maximum credit,
- ... solve problems symbolically first showing logic and reasoning for solution,
- ... substitute numbers into the equations clearly showing any required unit conversion factors
- ... then and only then crunch numbers on your calculator.

If I only have to punch your numbers into a calculator to get a correct answer (including units) you will receive full credit. **Don't make me guess what you are doing and why you chose to do this.**

(4) Watch the time and feel free to remove the staple and take the test apart so that you don't have to keep flipping pages around.

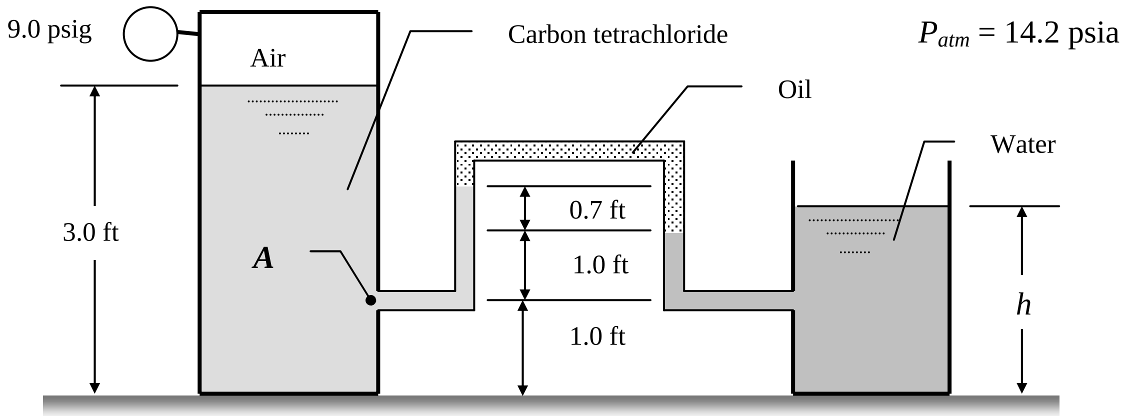
PLEASE REMOVE THE STAPLE AND USE EXTRA PAPER *INSTEAD* OF WRITING ON THE BACK OF PAGES AND THEN HAVING TO FLIP BACK AND FORTH TO FINISH THE PROBLEM. I'LL GLADLY RESTAPLE YOUR TEST!

Problem 1 (29 points)

An inverted U-tube manometer containing oil (SG = 0.8) is located between two reservoirs as shown in the figure. The reservoir on the left, which contains carbon tetrachloride ($\gamma_{\text{carbon tetrachloride}}$ = 99.5 lbf/ft^3), is closed and pressurized with air. The pressure gage attached to the tank indicates that the air pressure in the tank is 9.0 psig. The reservoir on the right contains water (γ_{water} = 62.4 lbf/ft^3) and is open to the atmosphere. Assume atmospheric pressure is measured to be 14.2 psia, and there is no fluid flowing between the reservoirs.

(a) Determine the pressure at point *A*, in psia .

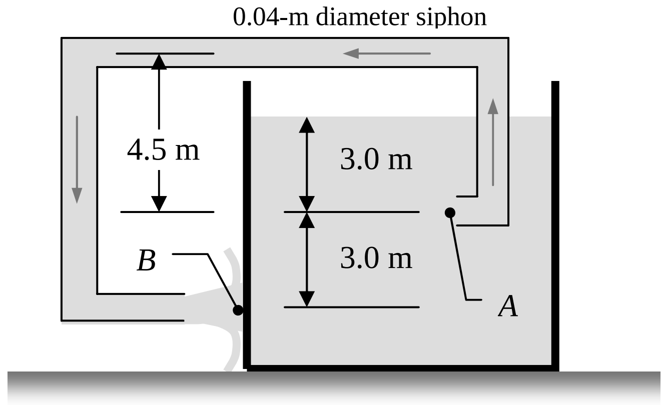
(b) Determine the depth of the water, *h*, in the right reservoir.



Problem 2 (29 points)

Water is siphoned from a tank as shown in the figure at right. Neglect losses in the siphon.

Water Data: $\rho = 999\ kg/m^3$; $\gamma = 9.80\ kN/m^3$



(a) Determine the volumetric flow rate through the siphon.

(b) Determine the pressure at point *A*, the inlet to the siphon. Report your answer in either kPa (abs) or kPa (gage).

(c) Determine the pressure at point *B*, a stagnation point. Report your answer in either kPa (abs) or kPa (gage).

Problem 3 (42 points)

An air turbine attached to a compressed air tank is used to start an emergency diesel engine-generator.

The compressed air tank has a regulator attached so that the inlet pressure to the air turbine is maintained at 300 kPa and the inlet temperature is measured to be 27°C. The air leaves the turbine at 100 kPa and –33°C. Under steady-state, adiabatic conditions the turbine delivers 15 kilowatts of shaft power to the diesel engine.

Assume that air can be modeled as an ideal gas. (*If you desire* you may treat it's specific heat as a constant at the value of the inlet temperature, i.e. c_p = 1.005 kJ/(kg·K)). Changes in kinetic and gravitational potential energy are negligible.

(a) Determine the mass flow rate of air through the turbine, in kg/s.

(b) Determine the adiabatic efficiency of the air turbine.

(c) Sketch the process for the air flowing through the turbine on a *T*-*s* diagram.