ES 202 - Exam III Spring 2000-2001 Richards

Name:____ Campus Mail Box ____________

Problem 1-A (50) __________

Problem 1-B (12) __________

Problem 2 (38) __________

TOTAL (100) __________

General Comments

(1) Anytime you apply a conservation or accounting principle in solving a problem, you must **sketch and clearly identify the system** you have selected. In addition, you must **clearly indicate how your assumptions or information given in the problem simplifies the general equations.**

(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,
... substititute 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.**

NOTE: Since the main focus of this test is on finding properties, be sure you demonstrate that you can find the appropriate numerical values. Don't just say "Look in the tables."

(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.

Problem 1 - Part A (50 points)

Complete the unshaded portions of the table for **R-134a**:

For **phase**, clearly indicate whether it is a compressed liquid (CL), saturated liquid (SL), saturated mixture (SM), saturated vapor (SV), or superheated vapor (SHV).

For **properties** and **quality**, provide a number or indicate it is not applicable (N/A).

(Entries that require calculations are worth 4 points. Entries that only require a simple look up are worth 2 points.)

State	Phase	*T* °C	*P* bar	*x*	*υ* m^3/kg	*h* kJ/kg	*s* kJ/(kg·K)
1			6				0.5000
2			6			280.60	
3		8	6				
4			6	0.70			
5		40	6				
6	SL	40					
7		40					1.000

For answers that require calculations, show your work below as you feel necessary. ***Full credit* will be given if I only have to punch *your* numbers into *my* calculator.**

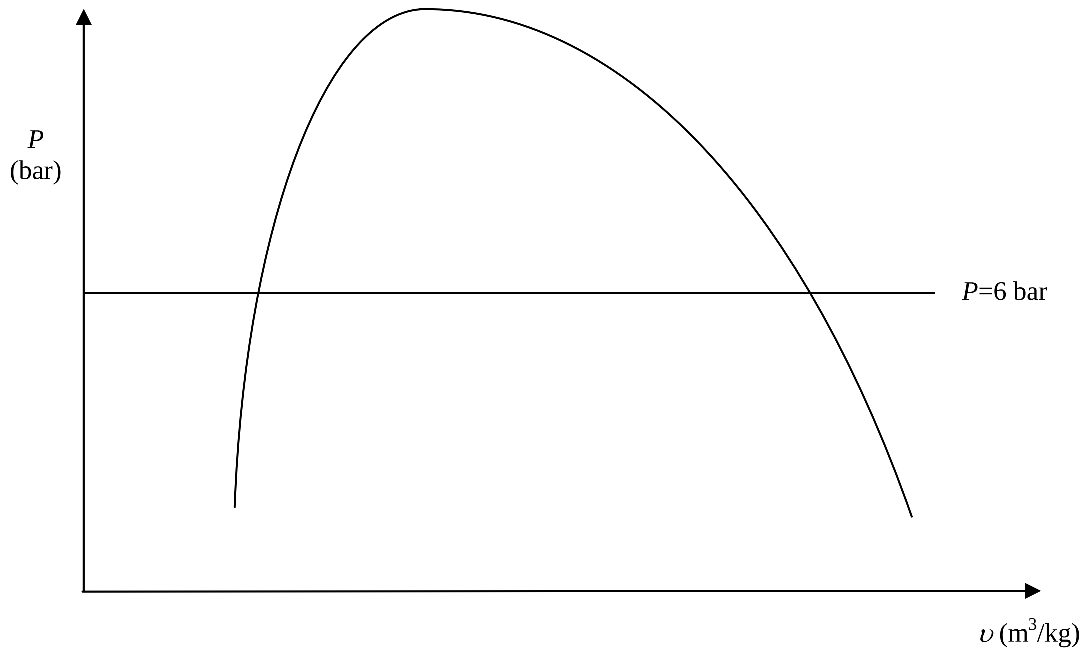
Problem 1 - Part B (12 points)

On the P-υ diagram drawn below,

(a) sketch the **40°C isotherm** and the **8°C isotherm**, *and*

(b) **locate and label States 1 - 6** found in Problem 1- Part A on the previous page.

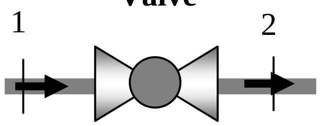
Take care to accurately place each point with respect to the saturation lines, the 8°C and 40°C isotherms, and the 6 bar isobar.



Problem 2 (38 points)

As part of President G.W. Bush’s new emphasis on energy conservation, you have been asked to investigate how much shaft power can be obtained by replacing a valve with a small turbine. The proposed *new* design with the available state information is shown in the figure below:

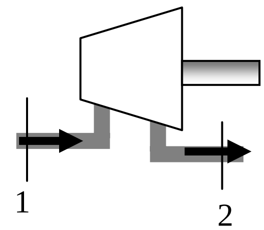
Original Design with Valve



New Design with Turbine

State 1: P_1 = 80 bar, T_1 = 360 K

State 2: P_2 = 40 bar, T_2 = 300 K



The adiabatic turbine is designed to operate with negligible changes in kinetic energy and gravitational potential energy at steady-state conditions.

Determine the power per unit mass flow rate, $\dot{W}/\dot{m}$ in kJ/kg, and the entropy production rate per unit mass flow rate, $\dot{S}_{gen}/\dot{m}$ in kJ/(kg-K), for the two cases below: [Note: Equations that apply equally to both cases need only be developed once.]

Case 1: The fluid is **air**. Assume that air can be modeled as an ideal gas and **use the ideal gas tables.** Do your answers give you any reason to doubt the feasibility of this process?

Case 2: The fluid is **liquid water**. Assume that liquid water can be modeled as an incompressible substance. Do your answers give you any reason to doubt the feasibility of this process?