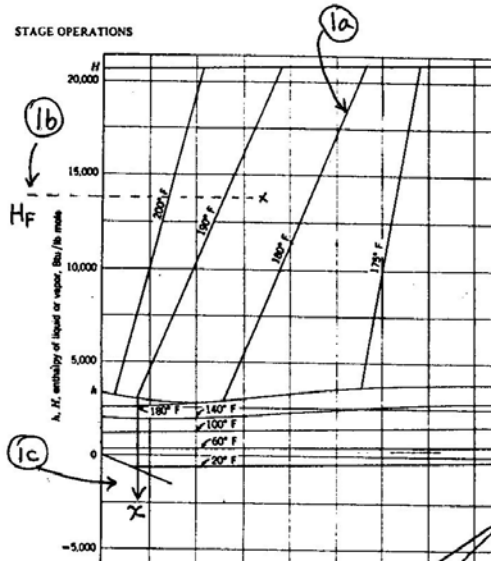
ChE 3660 – CHEN Separation Principles **Summer 2006**
Chemical Engineering Department **PRACTICE FINAL EXAM**
T.D. Placek **Auburn University**

Open Book Exam

Name (Print)_____

Departmental Honesty Statement: By affixing my signature below, I acknowledge I am aware of the Auburn University policy concerning academic honesty, plagiarism, and cheating. This policy is defined in the current Tiger Cub Student Handbook, Code of Laws, Title XII, Student Academic Honesty Code, Chapters 1200-1203. I further attest that the work I am submitting with this exam is solely my own and was developed during the exam. I have used no notes, materials, or other aids except those permitted by the instructor.

Signature_____



Instructions:

(1) Read each problem carefully before attempting to work.
(2) Show your work.
(3) Use your time wisely.
(4) Clearly indicate final answers.
(5) Accuracy of graphical solutions will be considered.

(6) Identify all important points and lines clearly on diagrams. For example, see the graph to the immediate left. This graph IS ONLY AN EXAMPLE. IT IS NOT PART OF THE EXAM MATERIALS.

1. (50%) A distillation process operating at 1.0 atm for the separation of ethanol and water is to be designed. The feed to the process is to be 600 lbmol/h of a 20% ethanol - 80% water solution at 100 ^{0}F. The column employs a partial condenser and a partial reboiler. Equilibrium data is provided in the form of x-y and H-x-y diagrams.

An engineer (who graduated from the "other" university in Alabama) was already working on this project. She was fired for not using drawing instruments when constructing graphical solutions and you have been asked to complete the design (and bring "honor" to Auburn University). The notes she left behind indicated the following additional information and specifications.

- The mole ratio of bottom product to top product is 4:1.
- The top product's concentration (mole fraction) is 10 times the bottom product's concentration (both referring to the ethanol component).
- The reflux ratio to be employed is either 0.5 or 1.5. The previous engineer spilled her coffee on her desk as she was packing up her "Tide" memorabilia and the spill makes it impossible to tell which is correct.

Answer the following questions:

a. Which reflux ratio would you recommend and why? (Justify your recommendation).
b. For the reflux ratio you recommend in (a) determine the total number of stages IN THE COLUMN.
c. Also, determine the optimal feed stage.

2. (60%) 1000 kg/h of a feed containing 48 wt% acetone (B), 2 wt% 1,1,2-trichloroethane (A) and 50wt% water (C) is sent to an extraction column to recover the acetone. 1424 kg/h of 98 wt% trichlor and 2 wt% acetone is used as the solvent stream. Two equilibrium stages are to be used. Equilibrium data in presented in the following table.

Phase compositions in mole percent

	phase1		phase2	
	A	B	A	B
	0.52	5.96	90.93	8.75
	0.73	17.04	73.76	25.14
	1.02	26.92	59.21	38.52
	1.17	30.88	53.92	42.97
	1.6	35.73	47.53	48.21
	2.1	40.9	40	53.95
	3.75	46.05	33.7	57.4
	6.52	51.78	26.26	60.34

Note: These data points have already been located in the figure on the next page.

a. Locate and clearly identify the plait point.
b. Draw and clearly label the auxillary (conjugate) line.
c. Fill in the following table (show your work and label important points on the diagram):

	Raffinate Phase	Extract Phase
Flowrate		
mass fraction acetic acid		
mass fraction water		
mass fraction trichlor		

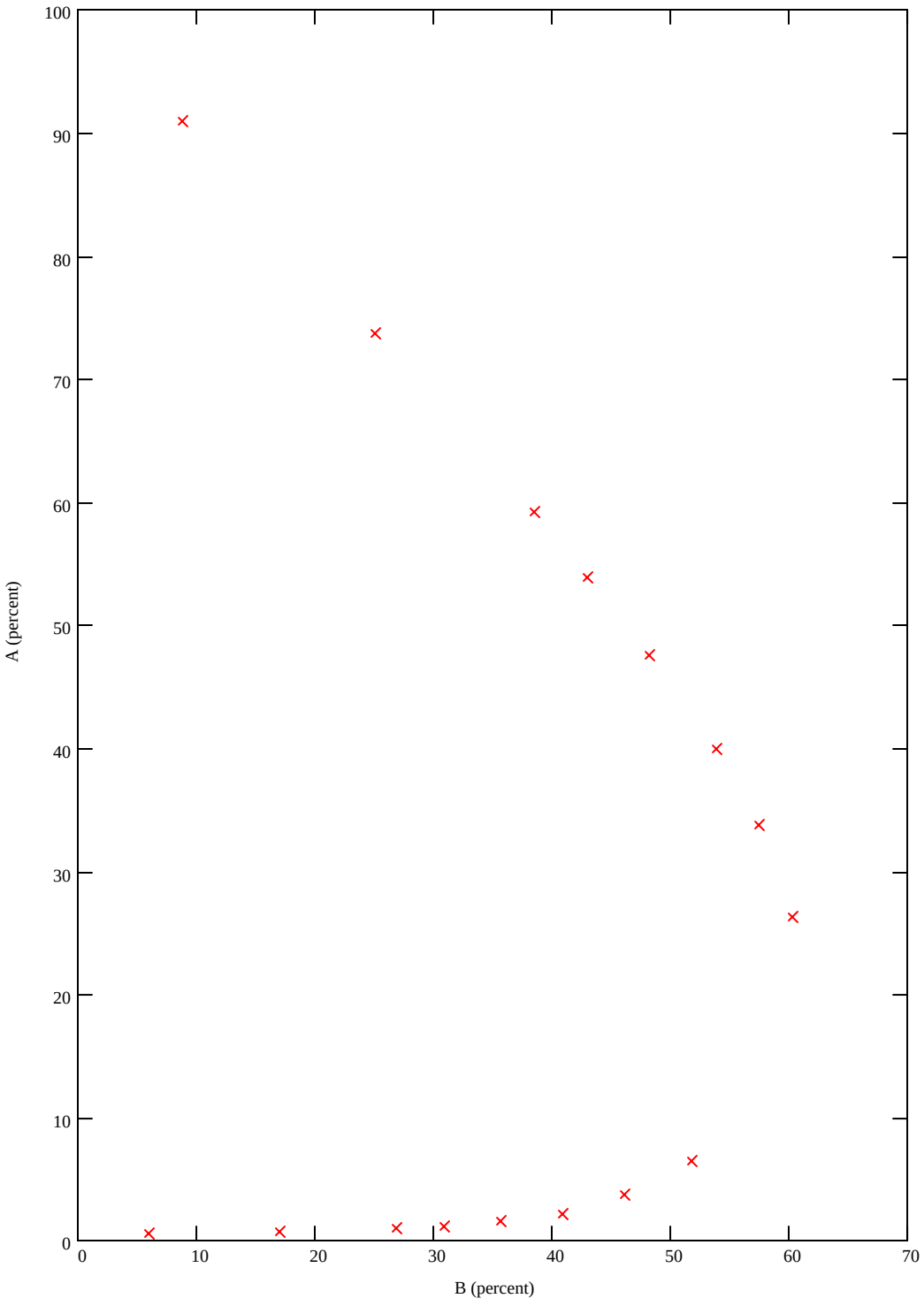
HINT: In that the problem gives the number of equilibrium stages, the solution is trial and error. Assume a value for R1, etc. You MUST VERIFY your solution (that is, it is NOT sufficient to just guess a value and use it without demonstrating that the value used was correct).

3. (50%) One thousand (1000) kg/h of a pressurized subcooled liquid feed containing 30 mole% n-hexane, 40 mole% n-heptane, and 30 mole% n-octane is subjected to a single stage flash distillation at 1.5 atm. 60% of the feed stream is vaporized. Using the vapor pressure information provided to establish equilibrium data, determine the following:

   a. The composition of the vapor product
   b. The composition of the liquid product
   c. The temperature of the flash

4. (40%) Six hundred (600) kg/h of a saturated vapor feed containing 50 mole% ethylene dichloride and 50 mole% benzene is fed to a distillation column operating at 1.0 atm. Reflux is a saturated liquid and constant molal overflow can be assumed valid. We desire to produce a vapor distillate product containing 99.0 mole% of the benzene and a liquid bottoms product that is 0.50% benzene. Equilibrium data can be approximated with an average relative volatility of 1.11 (MVC=benzene). The column will be operated at 20% over minimum reflux.

   a. What will be the flowrate of reflux liquid?
   b. What will be the number of stages required for this separation?


A (percent)
B (percent)
0
10
20
30
40
50
60
70
80
90
100