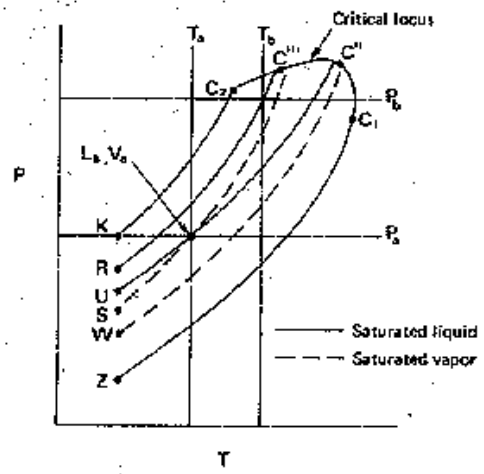
化工熱力學

1. A P-T diagram of a binary mixture is shown below. Please answer the following questions from this diagram. Note that the curves are of constant compositions.



a) what is the point (L_a, V_b) (5%)

b) what are the points C_1 and C_2 (4%)

2. The relative volatility is defined as $\alpha_{12} = \dfrac{k_1}{k_2} = \dfrac{y_1/x_1}{y_2/x_2}$. Please obtain the value of α_{12} at azeotripic point for a binary mixture? (3%)

3. Define excess Gibbs free energy and give its applications as many as possible. (6%)

4. At vapor-liquid equilibrium of a binary mixture, we should have the equilibrium condition

$$y_i \hat{\phi}_i^v P = x_i \gamma_i p_i^s \phi_i^s \exp\left[\int_{p_i^s}^{P} \frac{v_i^l}{RT} dp\right]$$

Where the notations are familiar in thermodynamics and need no explanation. The following experimental data of mixture A + B are given below

T=355.17 K		
x_A	y_A	P/mmHg
0.000	0.000	700
	0.427	1042
0.500	0.533	1118
0.750		
1.000	1.000	800

Please fill in the blanks with correct values. (you may use $\ln \gamma_A = B(1-x_A)^2, \gamma_B = B(1-x_B)^2$). Do your computations on your answer sheet so that I can judge how is your work and give you marks. (9%)

5. 对一密闭系统之不可逆循环程序证明 $\oint \frac{dQ_{irr}}{T} < 0$，并由其证明 $dS > \frac{dQ_{irr}}{T}$. (10%)

6. 以數學式寫出多相多反應平衡之充要條件. (6%)

7. 对動量、熱及質量等傳送各舉一例，以 entropy 之變化証明其為不可逆程序. (9%)

化學反應工程

8. In the homogeneous gas-phase reaction (12%)

$$5A + 4B \rightarrow 3C + 6D$$

the rate law is $-r_A = k_A C_A{}^* C_B{}^2$, if k_A is a value of 50 with the appropriate combination of units of mol, dm^3, g cat, and s.

(a) What will be the relationship between r_A and r_B?

(b) What will be the value k_C (rate constant)?

9. The following system of gas phase reactions: (13%)

$A \rightarrow B$	$-r_{A1} = 2$ (mol/ dm^3*min)
$A \rightarrow C$	$-r_{A2} = 6$ (min^{-1})*C_A
$A \rightarrow D$	$-r_{A3} = 18$ (dm^3/mol*min) *$C_A{}^2$

(a) Suggest a reaction system and conditions to minimize B and D for the parallel reactions.

(b) If the molar flow rate of A into the system is 1.0 mole/ min, and the final conversion of A is 0.9, please calculate reactor volume V? (gas constant R = 8.314 m^3*Pa/ mol*K; T=273℃; Pressure=405.3kPa)

10. An elementary reaction A + B → R + S takes place in a mixed-flow reactor with equal molar quantities of A and B in liquid phase. Conversion is 90 %, $C_{A0} = C_{B0} = 3.5$ mol/liter. If a plug-flow reactor four times as large as the mixed-flow reactor were hooked up in series with the existing unit, which unit should come first and by what fraction could production be increased for that setup? Conversion is remained unchange. (12%)

11. A reactant A is converted to a product P in a CSTR of volume V m^3. The feed to the plant v m^3/hr is a dilute solution of A in C_{A0} kg-mole/m^3 and the reaction is first-order in A with rate constant k hr^{-1}. The cost of the process is proportional to the reactor volume V. The income of the process is directly proportional to the amount of P made. Find the volume of the reactor that will maximize the profit from the system with the given C_{A0}, v, and k. (13%)