所別：化學工程與材料工程學系碩士班 甲組(一般生)　科目：化工熱力學及化學反應工程　共 2 頁 第 1 頁

本科考試可使用計算器，廠牌、功能不拘

＊請在試卷答案卷（卡）內作答

參考用

1. (15%)

Please derive the variation of Gibbs energy with pressure and temperature starting with the definition of Gibbs energy, G=H-TS. With above derivation, find the expression of gas for the change in molar Gibbs energy when the pressure is changed from p_i to p_f? If, the gas does not follow perfect gas law with the compression factor (Z) less than 1, then is the change greater or smaller than the gas is a perfect gas?

2. (10%)

Figure 1 shows the phase diagram for two partially miscible liquids. Describe what will be observed when a mixture of composition b_3 is heated, at each stage giving the number, composition, and relative amounts of the phases present. The "x" point is said to form an azeotrope of the mixture. Please explain why this azeotrope forms from molecular level of solvent-solute interactions.

3. (15%)

The benzene (B)-2,2,4-trimethyl pentane (P) mixture data for the vapor and liquid compositions and equilibrium total pressures at 55 °C are given in Table 1. The vapor pressure of pure benzene at 55 °C is 0.43596 bar, and that of 2,2,4-trimethyl pentane is 0.23738 bar

a. Calculate the activity coefficients of benzene and 2,2,4-trimethyl pentane and excess Gibbs free energy of the mixture $\underline{G}^{ex}$. (10 %)

b. Check the thermodynamic consistency of the experimental data. (5 %)

4. (10%)

Hydrogen can be generated from the following water splitting reaction: $H_2O_{liquid} \rightarrow H_{2\ gas} + 1/2\ O_{2\ gas}$. Estimate the Gibbs free energy change of the reaction at 80 °C. Please state the assumptions made. [$\Delta G_{formation}$ (25 °C, 1 bar, H_2O_{liquid}) = -237.1 kJ/mol; $\Delta H_{formation}$ (25 °C, 1 bar, H_2O_{liquid})= -285.8 kJ/mol]

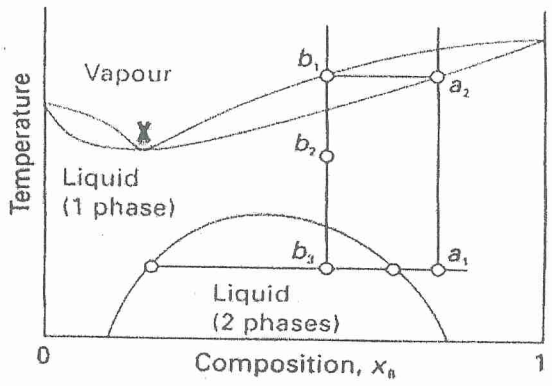

Figure 1

Table 1

x_B	y_B	P (bar)
0.0819	0.1869	0.26892
0.2192	0.4065	0.31573
0.3584	0.5509	0.35463
0.3831	0.5748	0.36088
0.5256	0.6786	0.39105
0.8478	0.8741	0.43277
0.9872	0.9863	0.43641

注意：背面有試題

5. (10%)

a. On increasing four folds of reactant concentration, the rate of reaction increases by eight folds. Find the reaction order.

b. Find the rate constant of a first-order gaseous reaction as 2A→R. On holding the pressure constant, if the volume of the mixture starting with 80% A, decreased by 20% in 5 min.

6. (8%)

The off gas from a boiling water nuclear power reactor contains a whole variety of radioactive trash, one of the most troublesome being Xe-133 (half life = 5.2 days). This off gas flows continuously through a large holdup tank in which its mean residence time is 60 days, and where we can assume that the contents are well mixed. Find the fraction of activity removed in the tank.

7. (7%)

Pure gaseous A was decomposed into R as A→3R. The initial concentration of A was 120 mmol/liter and fed into a 1-liter mixed flow reactor at various flow rates. And the exit concentration was measured and listed as follows:

v_0	liter/min	0.06	0.48	1.5	8.1
C_A	mmol/liter	30	60	80	105

Please find the rate reaction.

8. (25%)

An elementary reversible liquid-phase reaction $2A \rightleftharpoons B+C$ is carried out in a packed-bed reactor adiabatically. Pure A with concentration of 100 mol/m^3 is fed at 350K, and the volumetric flow rate is 0.5 dm^3/s

Additional information

$\triangle H°_{Rx}$ = -20 kcal/mol of A

The heat capacities of all species are all 200 cal/mol-K

The specific reaction rate is 10 dm^6/mol-kg cat.-min at 350K, and the activation energy is 30 kJ/mol

The equilibrium constant is 7,000 at 0°C

The diameters of the pipe and the catalyst pellet are 2 cm and 3 mm, respectively.

The density of catalyst pellet is 4 g/cm^3 and the porosity is 40%

a. What the length of the PBR should be to reach 75% of the equilibrium conversion? (15 %)

b. What should the inlet temperature be if you would like adjust the equilibrium conversion to 0.7? (5%)

c. Connecting two PBRs by a cooler is an alternative strategy. The equilibrium conversion is achieved in the first reactor before entering the cooler. What should the inlet temperature of the second reactor be if you would like adjust the final equilibrium conversion to 0.7? (5%)