國立中央大學八十五學年度碩士班研究生入學試題卷

所別: 化學工程研究所　不分組　科目: 化工熱力學及化學反應工程　共 1 頁 第 1 頁

Problem 1

One kg of water in your home's refrigerator (which is at -1 °C and 1 atm) freezes and becomes 1 kg of ice.
(a) (2 points) Does the entropy of the water increase, decrease, or remain constant when it freezes? Explain.
(b) (2 points) The heat of fusion for ice is 80 kcal/kg. Estimate the entropy change for the water when it freezes.
(c) (6 points) Schematically, draw the entropy, enthalpy, and Gibbs free energy of water as a function of temperature from -20 °C to 20 °C. Draw them separately.
(d) (2 points) What is the 2nd law of thermodynamics in terms of entropy?
(e) (3 points) Does the freezing of water violate the 2nd law considering the change of entropy? Please explain.

Problem 2

Experimental values of the equilibrium constant K for the reaction

$$H_2 + CO_2 = H_2O + CO$$

are

T (Kelvin)	K
800	0.197
1000	0.584
1200	1.151

(a) (5 points) Calculate ΔH° for the above reaction.
(b) (5 points) We know further that for the reaction

$$CO + 1/2O_2 = CO_2 \qquad \Delta G^\circ = -282420 + 87.03T \ [J].$$

Based on the above table and this information, can you calculate ΔG° for the reaction $H_2 + 1/2O_2 = H_2O$

Problem 3

Please write the unsteady state energy equation for a flow system, and indicate where and how are the heat and work terms involved in this equation.(8 points).

Problem 4

What are the uses of the equation of state? Give a list with examples (5 points).

Problem 5

(a) (5 points) What are the thermodynamic relationships between a liquid mixture and its equilibrium vapor.
(b) (7 points) What is the information needed to determine the equilibrium compositions in the vapor phase given that in the liquid phase. You should assume that both the vapor and the liquid phases are nonideal .

Problem 6

The conversion of an elementary liquid phase second-order reaction $2A \rightarrow 2R$ is 2/3, when operated in an isothermal plug flow reactor with a recycle ratio of unity. What will be the conversion if the recycle stream is shut off. (10 points)

Problem 7

The following data are given for an elementary reversible liquid phase reaction $A \Leftrightarrow B$

$H_A^\circ(298K) = -40{,}000$ cal/mol, $H_B^\circ(298K) = -60{,}000$ cal/mol
$C_{pA} = 50$ cal/mol.K, $C_{pB} = 50$ cal/mol.K
equilibrium constant $K_c = 100{,}000$ at 398K

What are the equilibrium conversions at 298, 350, 400, 450K respectively. If one wants to plot the relationships between conversion and temperature, what are the coordinates to be used. What do you expect to find in such a graph (15 points)

Problem 8

(a)(5 points) What are the assumptions made in an ideal CSTR reactor model.
(b)(3 points) What is the residence time distribution predicted based on the above assumptions.
(c)(5 points) If we have a real CSTR reactor which is not well stirred, what kind of change will you expect to see in its residence time distribution, relative to that predicted by the ideal model.
(d)(5 points) What are the assumptions made in an ideal plug flow reactor model.
(e)(2 points) What should the residence time distribution be for the ideal plug flow reactor model.
(f)(5 points)Under what conditions will a liquid phase packed bed reactor approaching the predictions of an ideal plug flow reactor.