國立成功大學
113學年度碩士班招生考試試題

編　號： 73

系　所： 化學工程學系

科　目： 化工熱力學

日　期： 0201

節　次： 第 2 節

備　註： 可使用計算機

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Problem 1 (13%)

Internal pressure can be used to measure the change in internal energy of a system when it expands or contracts at constant temperature, $(\frac{\partial U}{\partial V})_T$. (U and V are the molar properties)

(a) Please show the internal pressure of a gas obeying ideal gas behavior or van der Waals equation, $\left(P + \frac{a}{V^2}\right)(V - b) = RT$. **(5%)**

(b) A gas is assumed to obey the van der Waals equation and these two parameters, a = 1.4 $(\frac{atm \times dm^6}{mol^2})$ and b = 0.04 $(\frac{dm^3}{mol})$. If 5 mol of this gas expands reversibly isothermally at 300 K from an initial volume of 2.5 dm^3 to a final volume of 10 dm^3, please calculate the changes in heat (Q), work (W), internal energy (U), and enthalpy (H) during the expansion process. **(8%)**

Problem 2 (9%)

A liquid with a boiling point at 450 K and 1 atm. This liquid can be superheated to 465 K at 1 atm and then changing to vapor at the same temperature and pressure. Is this process spontaneous?

PS: $\Delta H_{vap} = 45.6\ \frac{kJ}{mol}$ at 450 K and 1 atm. $C_{p,l} = 78\ \frac{J}{K-mol}$ and $C_{p,g} = 35\ \frac{J}{K-mol}$. **(9 %)**

Problem 3 (12 %)

Calculate the maximum temperature of complete combustion of ethylene at 298 K with:

(a) The theoretical amount of air at 298 K. **(6%)**

(b) 20% excess air at 298 K. **(6%)**

	ΔH_f^0 (298K) (kJ/mol)	C_p^0	
		A (J/K-mol)	10^3B (J/K^2-mol)
C_2H_4(g)	52.5	11.8	119.7
H_2O(g)	-241.8	30.5	10.3
H_2O(l)	-285.8	75.5	0
CO_2(g)	-393.5	44.2	8.8
O_2(g)	0	30.0	4.2
N_2(g)	0	28.6	3.8

PS: $C_p^0 = A + BT$ is used over the working temperature region

C_p^0 and ΔH_f^0 mean the heat capacity and enthalpy at standard state (1 atm and 298 K)

Problem 4 (20%)

The equation of state for the van der Waals (vdW) fluid is given as $\left(P+\frac{a}{V^2}\right)\cdot(V-b)=RT$, where ***P***, ***V***, and ***T*** are the pressure, molar volume and temperature, respectively, as well as ***a*** and ***b*** are constants specific to this vdW fluid.

(1) Please calculate the residual internal energy of this vdW fluid, U^R. **(8%)**

(2) Please estimate the residual enthalpy of this vdW fluid, H^R. **(8%)**

(3) Please compute $\left(\frac{\partial C_v}{\partial V}\right)_T$ of this vdW fluid. **(4%)**

Please clearly state all assumptions you made leading to your answers. Express U^R, H^R and $\left(\frac{\partial C_v}{\partial V}\right)_T$ with proper thermodynamic variables. In your answers to (1) and (2), you could use C_P^R and C_V^R for isobaric and isochoric residual heat capacities, respectively.

Problem 5 (13%)

One mole of an ideal gas with C_P = (7/2) R and C_V = (5/2) R is compressed adiabatically in a piston-cylinder device from 2 bar and 300 K to 8 bar. The process is irreversible and requires 40% more than a reversible, adiabatic compression from the same state to the same final state on the same piston-cylinder device. Please calculate the final temperature and the entropy change of the gas.

Problem 6 (6%)

G^E/RT, $ln\,\gamma_1$, $ln\,\gamma_2$ must intersect at a point. If this were the case, please prove that it is real.

Problem 7 (8%)

Determine the following statements are "True" or "False".

(1) $x_1\bar{G}_1+x_2\bar{G}_2=G$, therefore $x_1\left(\frac{\partial \bar{G}_1}{\partial T}\right)_{P,x}+x_2\left(\frac{\partial \bar{G}_2}{\partial T}\right)_{P,x}=\left(\frac{\partial G}{\partial T}\right)_{P,x}$ Hence, $-x_1\bar{S}_1-x_2\bar{S}_2=-S$

(2) When $x_2\rightarrow 1$, the slope of $ln\,\gamma_1$ vs x_1 approaches 0.

背面尚有試題

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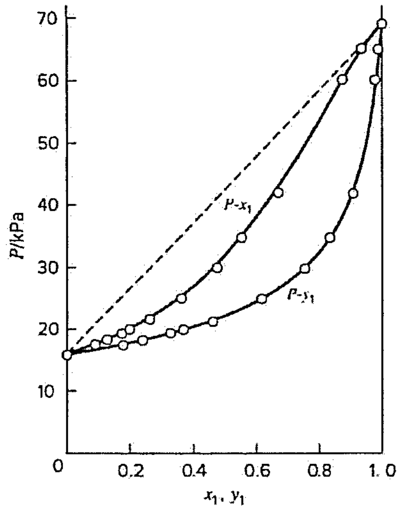
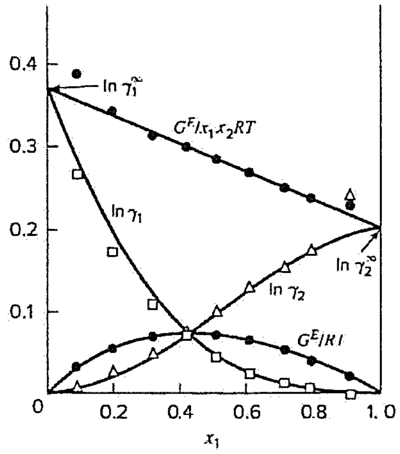
Problem 8 (5%)

Which figure (Figure (b) or Figure (c)) is related to Figure (a)? Please choose.

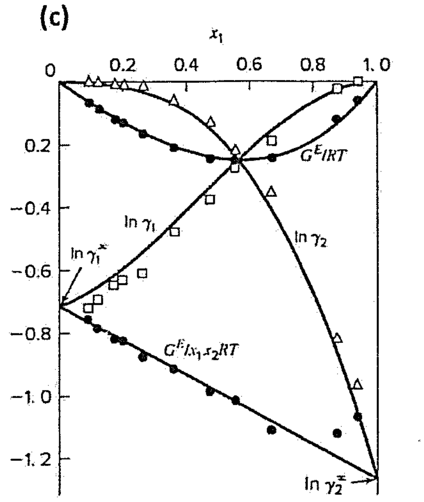
(a)



(b)



(c)



Problem 9 (14%)

(a) Please choose two from the sections (a), (b), (c), (d), (e), (f) which are related to Fig. 1. **(8%)**

(b) Please explain the reason on your choice. **(6%)**

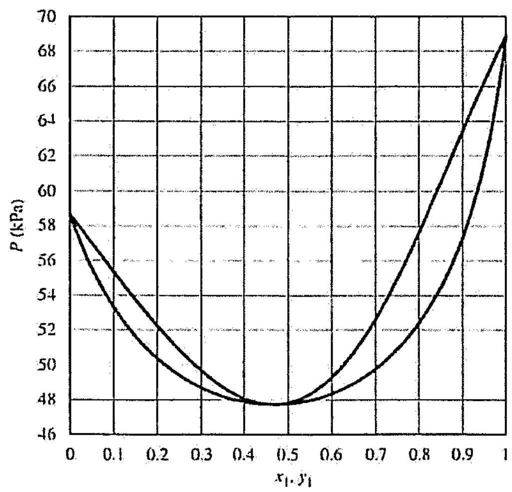


Fig. 1 *Pxy* diagram for vapor/liquid equilibrium of a mixed-solvent system at 50°C.

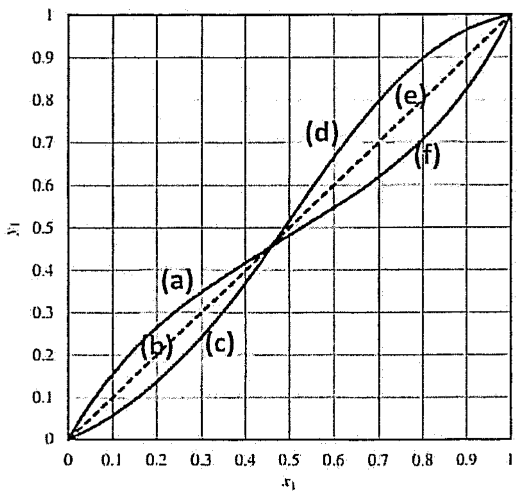


Fig. 2 xy diagram for different mixed-solvent system at 1 bar.