

元智大學 102 學年度研究所 碩士班 招生試題卷

系(所)別： 化學工程與材料 組別： 不分組-選考 A 科目： 化工熱力學與化工動力 用紙第 1 頁共 2 頁  
科學學系碩士班 學

●可使用現行「國家考試電子計算器規格標準」規定第二類之計算機

NOTES:

- Property data required to solve a given problem are provided in the problem statement or supplement. If you are unable to locate the required data, you still have the opportunity to provide a solution methodology.
- Any non-communicating calculator is permitted.

Problems

- As we know that methane gas hydrates are formed from liquid water by the following equation:  $\text{CH}_4(\text{g}) + 5.75\text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_4 \cdot 5.75\text{H}_2\text{O}(\text{s})$ ; (a) Please calculate the Gibbs energy of formation of the hydrate at 278 K and 283 K using the information that the methane partial pressure in the equilibrium with the hydrate at 278 K is 4.2 MPa and at 283 K is 6.8 MPa. (b) A common way to prevent hydrates from forming is by addition of an inhibitor to the system, usually methanol or salt. If 10 wt % methanol is added to water, what will be the equilibrium partial pressure for the methane for hydrate formation at 278 K and 283 K? (Assume no methanol is present in the vapour) (20 %)

Component-I-Component-II	Temperature Range (°C)	$\alpha$	$\beta$
Methanol-water	25	0.58	0.46
	64.6~100	0.83	0.51

- One mole of oxygen gas are to be compressed isothermally with reduced properties,  $V_r = 3$  and  $P_r = 3$ , to  $150 \text{ cm}^3 \text{ mol}^{-1}$ . Under these conditions, the behaviour of the gas is well described by the van der Waals equation of state. (20%)
  - Estimate the pressure at the final state of nitrogen gas? ( $T_c=154.6 \text{ K}$ ;  $P_c=50.43 \text{ bar}$   $V_c=73.4 \text{ cm}^3 \text{ mol}^{-1}$ ) (5%)
  - What is fugacity of oxygen at final state if excess Gibbs energy of oxygen equals to 128 joule  $\text{mol}^{-1}$ ? (5%)
  - If the nitrogen gas with same initial reduced properties is performed to 500 K and 12 MPa at constant volume. What is the total enthalpy change? (Data:  $C_p^*$  is  $3.639+0.506 \cdot 10^{-3}T$ , and  $\alpha = 3.12 \cdot 10^{-4}$ ) (10%)
- Describe the fundamental principles of thermodynamics. (10%)

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4. The reaction  $A \rightarrow B$  was carried out adiabatically and the following conversion vs. reaction rate data were recorded. The entering molar flow rate of A was 300 mol/min. (a) What is the CSTR (continuous stirred tank reactor) volume necessary to achieve 40% conversion? (b) If this CSTR is connected by another PFR (plug flow reactor), and the final conversion out of the PFR is 60%, what is the volume of the PFR? (20 %)

X	0	0.2	0.4	0.45	0.5	0.6	0.7	0.8	0.9
$-r_A$ (mol dm <sup>-3</sup> min <sup>-1</sup> )	1.0	1.67	5.0	5.0	5.0	5.0	0.5	1.25	0.91

5. The gas phase reversible elementary reaction:  $A \leftrightarrow 2C$  carried out in a flow reactor isothermally with no pressure drop. Pure A enters at a temperature of 400K and 10 atm. At this temperature equilibrium constant  $K_C = 1.5 \text{ mol dm}^{-3}$ . Calculate the equilibrium conversion. (Universal gas constant =  $0.082 \text{ dm}^3 \text{ atm mol}^{-1} \text{ K}^{-1}$ ) (10 %)
6. For the irreversible gas phase elementary reaction:  $A+B \rightarrow C$  is carried out isothermally in a constant volume batch reactor. Both initial concentrations of A and B are  $1 \times 10^{-3} \text{ mol/dm}^3$ . Rate constant  $k = 100 \text{ mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$ . (a) Please give the rate expression in terms of conversion. (b) What is the time required to obtain 80% conversion? (20 %)

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