國立雲林科技大學
八十七學年度研究所碩士班入學考試試題

所別：化工所
科目：熱力學

一、Please explain the following terms.（20%）

（a）2nd Law of Thermodynamics（5%）

（b）Gibbs Phase Rule(With Chemical Reaction)（5%）

（c）Gibbs-Duhem Equation（5%）

（d）Principle of Corresponding States（5%）

二、（a）Express dH as a function of C_p，C_v，P，V，and T（10%），and

（b）Express dS in terms of dT and dP（10%）

三、A gas obeys the van der Waals equation，with P_c=30atm and T_c=210 ℃.The compressibility factor PV/RT will be more than one.（at P=50atm，T=250 ℃.；at P=1atm，T=100 ℃.；P=500atm，T=500 ℃.；none of these）

Calculate the van der Waals constant b for this gas.（20%）

Hint：$P_c V_c/RT_c$=3/8，V_c=3b

四、Determine whether the following process violates the laws of thermodynamics.

An ideal gas of constant heat capacity（C_p=5/2R）at 1 M Pa and 300 K enters a device which is thermally and mechanically insulated from the surroundings. One- half of the gas leaves the device at 360 K and 0.1 M Pa，while the other half leaves at 240 K and 0.1 M Pa.（25%）

五、A gas mixture is composed of two ideal gases. Please calculate the maximum $\triangle S_{mix}$ for the gas mixture.（$\triangle S_{mix}$：the entropy change of mixing）（15%）

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科目：動力學

1. 某一不可逆、氣相反應 $A + 2B \longrightarrow 2D$，定溫(55℃)、定壓(5.0atm)於柱塞流反應器 (Plug-flow reactor) 中進行。已知反應器入料組成爲：A = 20 mole%， B = 50 mole%， inerts = 30 mole%。若入料之體積流率爲 V_0，請問：
   (a) 反應進行時間爲 t 時，A 之轉化率(X)與當時之體積流率 V 之關係爲何？(5 分)
   (b) 反應進行時間爲 t 時，A、B 與 D 之濃度與轉化率(X)之關係分別爲何？(7 分)
   (c) 若此反應爲基本反應(Elementary reaction)，A 之反應速率方程式(Reaction rate equation)爲何？(5 分)
   (d) 反應器入口 A 與 B 之濃度(mole/liter)分別爲何？(8 分)

2. 某一不可逆、氣相、基本反應 $2A \longrightarrow B$，於定溫與定壓下進行。若 A 之起始濃度 C_{A0} 爲 2 mole/liter，A 之反應速率常數 K 爲 2 liter/mole-min，當 A 之轉化率 X 達 0.9 時，請問：
   (a) 若此一反應於柱塞流反應器(Plug-flow reactor)中進行，所需空間時間(Space time)爲何？(7 分) 若體積流率爲 5 liters/min，所需反應器之體積爲何？(5 分)
   (b) 若此一反應於連續攪拌桶狀反應器(Continuous-stirred tank reactor)中進行，所需空間時間爲何？(6 分)
   (c) 若此一反應於批式反應器(Batch reactor)中進行，所需反應時間爲何？(7 分)

3. Saponification is a reaction in which an ester is heated with aqueous alkali such as sodium hydroxide to form an alcohol. For saponification of ethyl acetate, $CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$, at 298 °K in a well-stirred batch reactor, the following data were collected:

Time, min	5	9	13	20	25	33	37
[NaOH], 10^{-3} g.mol/L	7.55	6.33	5.41	4.34	3.85	3.20	2.96

The run begins with equimolar (0.01 g.mol/L) amount of sodium hydroxide and ethyl acetate as the reactants. Show that the reaction can be considered to be irreversible and first-order in both reactants. Please also calculate the reaction rate constant at 298 °K. (25 分) (答案紙最後一頁有方格紙，若需使用的話)

4. Consider the following steps in autoxidation of a hydrocarbon RH:

Initiation: $In_2 \rightarrow 2In^*$

$In^* + RH \rightarrow InH + R^*$

Propagation: $R^* + O_2 \rightarrow ROO^*$

$ROO^* + RH \rightarrow ROOH + R^*$

Termination: $R^* + ROO^* \rightarrow ROOR$

Use the steady-state approximation and establish equation for the rate of oxidation of RH. (25 分)

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1. Solve the following ordinary differential equations:
   (1) $(3x+2y)\,dx + x\,dy = 0$. (7%)
   (2) $\frac{d^2y}{dx^2} - y = e^x(x^2-1)$. (10%)

2. Find all solutions to the following system of linear algebraic equations:
   $x_1 + 3x_2 - 5x_3 + x_4 = 4$
   $2x_1 + 5x_2 - 2x_3 + 4x_4 = 6$ (15%)

3. Find the eigenvalues and eigenvectors of $\underline{\underline{A}}$ where
   $\underline{\underline{A}} = \begin{bmatrix} 3 & -4 \\ 2 & -3 \end{bmatrix}$ (10%)

4. Find the equations of the tangent plane and the normal line to the given surface:
   $z = xy^2$ at the given point: (1, 1, 1). (15%)

5. Find the surface area of the plane $x + 2y + 2z = 12$ cut off by:
   $x = 0$, $y = 0$, and $x^2 + y^2 = 16$. (10%)

6. Using the Fourier integral representation for $f(x) = \begin{cases} 1 & \text{if } |x| < 1 \\ 0 & \text{if } |x| > 1 \end{cases}$, show that
   $\int_0^\infty \frac{\sin w}{w}\,dw = \frac{\pi}{2}$. (13%)

7. Solve the partial differential equation: $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial y^2}$, $0 < y < 1$, $t > 0$.
   I.C. $u = 1$ for $t = 0$; B.C. $u = 0$ for $y = 0$ and $y = 1$. (20%)