



- 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 $P_c=30\text{atm}$ and $T_c=210^\circ\text{C}$. The compressibility factor PV/RT will be more than one, (at $P=50\text{atm}$, $T=250^\circ\text{C}$; at $P=1\text{atm}$, $T=100^\circ\text{C}$; at $P=500\text{atm}$, $T=500^\circ\text{C}$; 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 MPa 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 MPa , while the other half leaves at 240 K and 0.1 MPa . (25%)
- 五、 A gas mixture is composed of two ideal gases. Please calculate the maximum ΔS_{mix} for the gas mixture. (ΔS_{mix} : the entropy change of mixing) (15%)



1. 某一不可逆、氣相反應 $A + 2B \longrightarrow 2D$ ，定溫(55°C)、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： $A = 20\text{ mole}\%$ ， $B = 50\text{ mole}\%$ ， $\text{inerts} = 30\text{ mole}\%$ 。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)

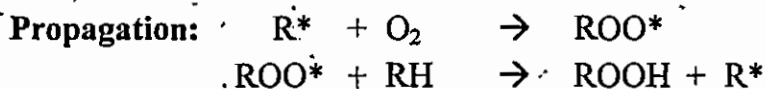
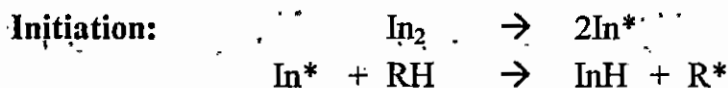


3. Saponification is a reaction in which an ester is heated with aqueous alkali such as sodium hydroxide to form an alcohol. For saponification of ethyl acetate, $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{C}_2\text{H}_5\text{OH}$, at 298 °K in a well-stirred 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:



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



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:

$$x_1 + 3x_2 - 5x_3 + x_4 = 4$$

$$2x_1 + 5x_2 - 2x_3 + 4x_4 = 6 \quad (15\%)$$

3. Find the eigenvalues and eigenvectors of \underline{A} where

$$\underline{A} = \begin{bmatrix} 3 & -4 \\ 2 & -3 \end{bmatrix} \quad (10\%)$$

4. Find the equations of the tangent plane and the normal line to the given surface:

$$z = xy^2 \text{ at the given point: } (1, 1, 1). \quad (15\%)$$

5. Find the surface area of the plane $x + 2y + 2z = 12$ cut off by:

$$x = 0, y = 0, \text{ and } x^2 + y^2 = 16. \quad (10\%)$$

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

$$\int_0^{\infty} \frac{\sin w}{w} dw = \frac{\pi}{2}. \quad (13\%)$$

7. Solve the partial differential equation: $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial y^2}$, $0 < y < 1, t > 0$.

$$\text{I.C. } u = 1 \text{ for } t = 0; \text{ B.C. } u = 0 \text{ for } y = 0 \text{ and } y = 1. \quad (20\%)$$