109CH03

國立臺北科技大學 109 學年度碩士班招生考試

系所組別：3510 化學工程與生物科技系化學工程碩士班甲組

第二節　化工熱力學與反應工程　試題

注意事項：

1. 本試題共 4 題，每題 25 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Consider the reaction　F → P + G

(a) Construct a rate law ($-r_F'$) by observing the data shown in the Table. (6%)

(b) Propose a mechanism for the reaction with the experimental data shown in the Table. (9%)

(c) Derive the rate-limiting step analysis to verify the proposed mechanism fits the rate law. (10%)

Run	Rate (mol/g cat. • s)	Partial Pressure (atm)		
		F	P	G
1	0.160	15	1	1
2	0.163	10	1	0
3	0.159	15	1	10
4	0.106	10	2	0
5	0.011	0.1	2	0
6	0.050	0.5	2	1

2. In a binary system, the excess Gibbs energy (G^E) can be expressed as follows.

$$R \cdot T \cdot G^E = Q \cdot X_1 \cdot X_2$$

where R is the idea gas constant, T is temperature, Q is constant, X_1 is the mass fraction of component 1, and X_2 is the mass fraction of component 2. Calculate the range of Q for two coexisting liquid phase and the composition range of component 2 with Q = 3. (25%)

3. Three reactions were connected with the sequence of PFR → CSTR → PFR, the entering molar flow rate (F_{A0}) is 30 kmol/h and the final conversion is 90%.

(a) What would be the reactor volume for **these three reactors** if two intermediate conversions (X_1 and X_2) are 50% and 75%, respectively? (15%)

(b) What is the conversions X_1 and X_2 if all these three reactors having the same volume? (6%)

(c) What is the worst way to arrange two PFR and one CSTR? (4%)

X	0.0	0.1	0.2	0.45	0.55	0.75	0.80	0.90
$-r_A$ (kmol/m^3·h)	0.63	0.84	1.25	1.25	1.25	1.25	0.63	0.42

4. A plant operates on a Brayton cycle with the pressure ratio of 9. The compressor inlet has a gas temperature of 300 K. Heat added in the chamber is 580 kJ/kg. The compressor isentropic efficiency is 70% and turbine isentropic efficiency is 75%. Determine the gas temperature at exit of compressor and turbine. (15%) Calculate the heat rejected per unit mass flow, and the efficiency of the Brayton cycle. (10%) Hint: C_p = 1.005 J/g·K