國立臺北科技大學九十七學年度碩士班招生考試

系所組別：3510 化學工程研究所甲組

第二節　化工熱力學與反應工程　試題

填 准 考 證 號 碼

注意事項：

1. 本試題共 5 大題，第 1 題 25 分，第 2 題 25 分，第 3 題 10 分，第 4 題 20 分，第 5 題 20 分，小題配分如後，總分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
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. The concepts of entropy

(1). For what reason and/or observation, let the scientist to constitute the second law of thermodynamics? (5 %)

(2). Explain the second law of thermodynamics in mathematical statement? (5 %)

(3). What's the internal energy and enthalpy? Why entropy is an abstract variable more then internal energy and enthalpy? (15 %)

2. An operation of heat-work exchange

A piston/cylinder device operating in a cycle with steam as the working fluid executes the following three steps.

(Step 1-2) Firstly, saturated-vapor steam at 15.538 bar initially is heated at constant pressure to 500°C. (Step 2-3) Next, it then expands, reversible and adiabatically, to the initial temperature of 200°C. (Step 3-1) Finally, the steam is compressed in a mechanically reversible, isothermal process to the initial state.

(1). Calculate the Q and W of each step. (12 %)

(2). What is the thermal efficiency of the cycle? (6 %)

(3). For your algorithm in this problem, discussion what terms of deviation will to bring in your calculation results and what reason to make these deviation? (7 %)

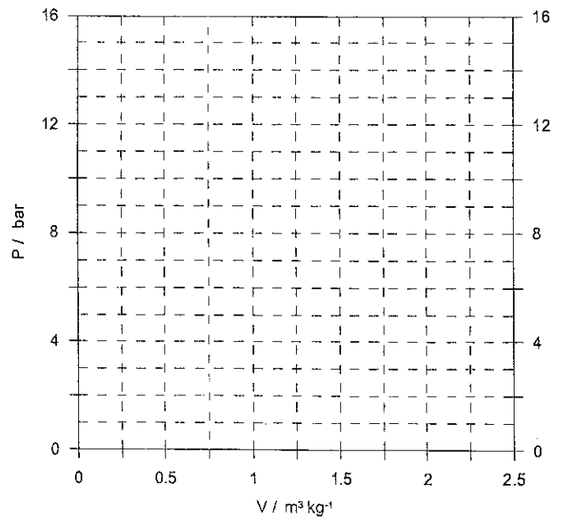
Table 1. The thermodynamic properties of superheat vapor of steam

P	$\hat{V}$	$\hat{U}$	$\hat{H}$	$\hat{S}$	$\hat{V}$	$\hat{U}$	$\hat{H}$	$\hat{S}$
	$T=200$°C				$T=500$°C			
1	2.1720	2658.1	2875.3	7.8343	3.5650	3131.6	3488.1	8.8342
2	1.0803	2654.4	2870.5	7.5066	1.7814	3130.8	3487.1	8.5133
3	0.7163	2650.7	2865.6	7.3115	1.1867	3130.0	3486.0	8.3251
4	0.5342	2646.8	2860.5	7.1706	0.8893	3129.2	3484.9	8.1913
5	0.4249	2642.9	2855.4	7.0592	0.7109	3128.4	3483.9	8.0873
6	0.3520	2638.9	2850.1	6.9665	0.5920	3127.6	3482.8	8.0021
8	0.2608	2630.6	2839.3	6.8158	0.4433	3126.0	3480.6	7.8673
10	0.2060	2621.9	2827.9	6.6940	0.3541	3124.4	3478.5	7.7622
12	0.1693	2612.8	2815.9	6.5898	0.2946	3122.8	3476.3	7.6759
14	0.1430	2603.1	2803.3	6.4975	0.2521	3121.1	3474.1	7.6027
15.538	0.1274*	2595.3*	2793.2*	6.4323*	---	---	---	---
16					0.2203	3119.5	3472.0	7.5390

P [=] bar; $\hat{V}$ [=] $m^3\ kg^{-1}$; $\hat{U}, \hat{H}$ [=] $kJ\ kg^{-1}$; $\hat{S}$ [=] $kJ\ kg^{-1}\ K^{-1}$

* the properties of steam at saturated state

※ Additional information : Referenced blank chart



注意：背面尚有試題

Ch2-1

3. **The effect of temperature on chemical reaction rates**

(1). What is the Arrhenius equation? (5 %)

(2). Explain how to find the activation energy of a chemical reaction. (5 %)

4. **The reaction order and rate constant**

A kinetic study for the chemical reaction of

$$2\,Br \xrightarrow{k} Br_2 \ ,$$

the concentration of bromine at various times after flash photolysis of a bromine - SF_6 mixture with $C_{Br_2}/C_{SF_6} = 6.4 \times 10^{-2}$ were listed in Table 2.

(1). Assumed that the pseudo reaction order is an integral, please find it. (10 %)

(2). Estimate the rate constant k and have to write out the units in your answer. (10 %)

Table 2. The data of concentration and times for the photolysis reaction

$C_{Br} \times 10^5$, M	t, μs
2.58	60
1.51	110
1.04	160
0.80	210
0.67	260
0.56	310

5. **Using least squares algorithm to determine rate law parameters.**

A kinetic study of dissolution of MnO_2 in HBr which we assume a rate law of the form:

$$-r''_{HBr} = k\,C^{\alpha}_{HBr}.$$

An experimental data were listed in Table 3, using the mathematic tools of least squares method to determine the reaction order and specific reaction rate.

(1). For a linear polynomial equation of degree 1,

$y = a\,x + b$,

derive the formulas of the linear least squares solution.(10 %)

(2). Using the previous formulas to calculate the reaction order α and specific reaction rate k. (10 %)

Table 3. The data of concentration and rates for the dissolution reaction

C_{A0} (mol HBr/dm^3)	$-r''_{A0}$ (mol HBr/m^2 · hr)
0.12	0.073
0.60	0.70
1.2	1.84
2.4	4.86
4.8	12.84