

# 淡江大學 101 學年度碩士班招生考試試題

系別：化學工程與材料工程學系

科目：物理化學

考試日期：2月26日(星期日) 第3節

本試題共五大題，2頁，第1頁

Gas constant  $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

1. A Carnot cycle uses 1 mol of an ideal gas for which  $C_p = 30 \text{ J K}^{-1} \text{ mol}^{-1}$  and  $C_v = 20 \text{ J K}^{-1} \text{ mol}^{-1}$ , as the working substance and operates from a most compressed state of a 20-bar pressure and 800 K. It expands isothermally to a pressure of 2 bar (step 1) and then adiabatically to a temperature of 400 K (step 2). This expansion is followed by an isothermal compression (step 3), and then an adiabatic compression back to the initial state (step 4).

(20 pts)

(a) Plot the changes of pressure (y-axis) with volume (x-axis) for the Carnot cycle.

(Indicate step 1 to step 4 on the graph)

(b) Plot the Carnot cycle on a graph of S (y-axis) versus T (x-axis).

(Indicate step 1 to step 4 on the graph)

(c) Calculate the total Q, total W,  $\Delta U$ ,  $\Delta H$ ,  $\Delta S$  for the whole cycle.

(d) Calculate the efficiency of the cycle.

2. For the reaction,  $A_{(g)} + 2B_{(g)} \leftrightarrow C_{(g)} + 2D_{(g)}$  at  $25^\circ\text{C}$  (25%)

	A	B	C	D
$\Delta H_f^\circ$ kJ/mole	-200.0	-100.0	-250.0	-150
$\Delta G_f^\circ$ kJ/mole	-180.0	-120.0	-200.0	-100

(a) Calculate the standard reaction enthalpy  $\Delta H_{\text{rxn}}$  at  $25^\circ\text{C}$ .

(b) Calculate the reaction Gibbs energy  $\Delta G_{\text{rxn}}$  at  $25^\circ\text{C}$ .

(c) Estimate the equilibrium constant at  $25^\circ\text{C}$ .

(d) When 1 mol of gas A and 2 mol of gas B are reacted to form C and D according to the above reaction at  $25^\circ\text{C}$  and the reaction reaches equilibrium at a total pressure of 2 bar, calculate the partial pressure (bar) of gas A at equilibrium. All gases are ideal.

(e) Assume a constant  $\Delta H_{\text{rxn}}$  value, estimate the equilibrium constant at  $50^\circ\text{C}$  by using the van't Hoff equation.

本試題雙面印刷

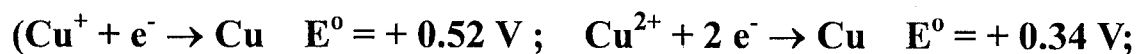
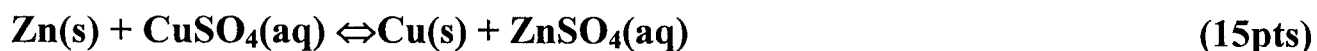
# 淡江大學 101 學年度碩士班招生考試試題

57-2

系別：化學工程與材料工程學系      科目：物 理 化 學

考試日期：2 月 26 日(星期日) 第 3 節      本試題共 五 大題， 2 頁， 第 2 頁

3. (a) Write down the Nernst equation. (b) Devise a cell in which the following is the reaction and then calculate the standard emf. (c) Calculate the equilibrium constant at 25°C.



4. (a) Derive the Clausius-Clapeyron equation for the variation of vapor pressure with temperature. If the vapor pressure of the liquid A is 650 Torr at 350 K and 700 Torr at 375 K, use the Clausius-Clapeyron equation to calculate (b) the enthalpy of vaporization  $\Delta H_{\text{vap}}$  (kJ/mol), (c) the normal boiling point (K), (d) the entropy of vaporization  $\Delta S_{\text{vap}}$  (J/K) at the normal boiling point. (Assume the  $\Delta H_{\text{vap}}$  is a constant over the temperature range)

(20pts)

5. The following data were obtained for the irreversible reaction  $\text{A} \rightarrow \text{B} + \text{C}$ ; and the reaction was found to be a first-order reaction.

(20 pts)

At 300 K		At 350 K	
Time (h)	A (mol/L)	Time (h)	A (mol/L)
0	0.1052	0	0.1080
5.0	0.0803	0.25	0.0885
10.0	0.0612	0.50	0.0727
15.0	0.0467	1.00	0.0491
30.0	0.0208	2.00	0.0224

(a) Derive the integrated rate law for the first-order reaction.

(b) Calculate the rate constant value (1/h) at 300 K. (Use least square method to calculate the slope of a linear equation)

(c) Calculate the rate constant value (1/h) and the half-life time (h) of A at 350 K. (Use least square method to calculate the slope of a linear equation)

(d) Estimate the activation energy (kJ/mol).

背面尚有試題