# 大同大學 102 學年度研究所碩士班入學考試試題

考試科目:物理化學　　所別:化學工程研究所　　

註:本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

1. (10%) The equilibrium constant $K_p$ for the reaction

$$N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$$

varies with temperature over the range 1500 K to 2500K according to the equation

$$\ln K_p = 3.13 - \frac{21900}{T\,(K)}$$

Calculate $K_p$, $\Delta G^0$, $\Delta H^0$, $\Delta S^0$ at 2000 K.

2. (10%) Consider the following quantities for a four-step engine cycle:

| | | |
|---|---|---|
| Step 1 | q = +850 J | W = –850 J |
| Step 2 | q = 0 J | W = –150 J |
| Step 3 | q = –623 J | W = +623 J |
| Step 4 | q = 0 J | W = +150 J |

Find (a) Will this be a Carnot-type cycle? Why?
(b) What is the efficiency of this cycle?
(c) What is the efficiency of this process if $T_{high}$ is 100 °C and whose $T_{low}$ is 20 °C?
(d) State briefly the processes of step 1 and step 4.

3. (10%) The determined emf (E) of a cell

$$Pt,\ H_{2(1bar,\,g)} \mid HCl_{(aq)} \mid AgCl,\ Ag_{(s)}$$

was found to be 0.317 V at 25 °C.
(a) What is the cell reaction?
(b) What is the pH of the HCl solution?

$AgCl_{(s)} + e^- \rightarrow Cl^-_{(aq)} + Ag_{(s)}$　　$E^0 = 0.2224$ V

4. (10%) Prove that
(a) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial P}\right)_T \left(\frac{\partial T}{\partial V}\right)_P = -1$ for an ideal gas
(b) The Gibbs phase rule F = C – P + 2
where F = the degree of freedom, C = the number of component and P = the number of phase

5. (15%) Construct the phase diagram for benzene ($C_6H_6$) in the vicinity of its triple point (36 torr, 5.5 °C) using the following data:

$\Delta_{fus}\bar{H}^0 = 10.6\ kJ/mol$　　$\Delta_{vap}\bar{H}^0 = 30.8\ kJ/mol$
$\rho_{(s)} = 0.91\ g/cm^3$　　$\rho_{(l)} = 0.899\ g/cm^3$

The Clapeyron equation for phase transition is

$$\frac{dP}{dT} = \frac{\Delta\bar{S}}{\Delta\bar{V}}$$

gas constant R = 8.314 J/mol K = 0.082 atm L/mol K

<背面繼續>

# 大同大學 102 學年度研究所碩士班入學考試試題



註:本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

<接前頁>

6. A reaction scheme can be expressed as

$$A + S \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} A \cdot S \xrightarrow{k_2} S + P$$

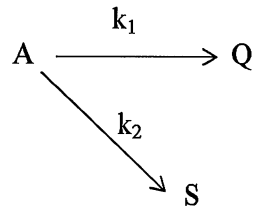
where S means catalyst and the initial concentration is $C_S^0$.

(a) (10%) Show that the rate of product P can be derived as $r_P = \frac{r_m C_A}{K_M + C_A}$.

(b) (5%) What is the physical meaning of $r_m$?

(c) (5%) Describe how to find the value of $r_m$ and $K_m$ if the concentration vs. time data were supported?

7. (10%) A parallel reaction system denoted as follows, where $C_A = C_{A0}$, $C_Q = C_S = 0$ at t = 0. Find the selectivity $C_Q/C_A$ at any time t.




8. Answer the following question briefly,

(a) (5%) How can we think a reaction as an "Elementary reaction"?

(b) (5%) If a homogeneous elementary reaction is thought as second order reaction, what is the unit for the rate constant? (Please define the unit for the reaction rate yourself.)

(c) (5%) What is Arrhenius equation? If we use such the equation to evaluate the activation energy and get different result for different temperature range, what comments will you give?