國立臺北科技大學 111 學年度碩士班招生考試

系所組別：3520 化學工程與生物科技系化學工程碩士班乙組

第一節　物理化學　試題

注意事項：

1.本試題共 5 題，每題 20 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. (a) What are the zeroth, first, second and third laws of thermodynamics? (10%)

   (b) Explain at least four methods for determining the rate equation of a chemical reaction. (10%)

2. When 131 mg of naphthalene, $C_{10}H_8(s)$, was burned in a bomb calorimeter the temperature rose by 3.16 K. Calculate the calorimeter constant ($= |q| / \Delta T$). By how much will the temperature rise when 181 mg of phenol, $C_6H_5OH(s)$, is burned in the calorimeter under the same conditions? ($\Delta_c H°(C_{10}H_8, s, 298\ K) = -5157\ kJ\ mol^{-1}$, $\Delta_c H°(C_6H_5OH, l, 298\ K) = -3054\ kJ\ mol^{-1}$, H = 1.0079 g mol^{-1}, C = 12.011 g mol^{-1}, O = 15.9994 g mol^{-1}). (20%)

3. Calculate the change in the entropies of the system and the surroundings, and total change in entropy, when a sample of nitrogen gas of 2 moles at 300 K and 1.00 bar triples its volume in

   (a) an isothermal reversible expansion. (6%)

   (b) an isothermal irreversible expansion against $P_{ex} = 0$ bar. (6%)

   (c) an adiabatic reversible expansion. ($C_p/C_v = 1.4$). (8%)

4. Consider the cell:

   $Zn(s) \mid ZnCl_2(aq, 0.0050\ mol\ kg^{-1}) \parallel Hg_2Cl_2(s) \mid Hg(l)$

   The cell potential is +1.2272 V, $E°(Zn^{2+}, Zn) = -0.7628$ V, and $E°(Hg_2Cl_2, Hg) = +0.2676$ V. Determine

   (a) the Nernst equation for the cell. (2%)

   (b) the standard cell potential. (2%)

   (c) $\Delta_r G$, $\Delta_r G°$, and K for the cell reaction. (6%)

   (d) the mean ionic activity and activity coefficient of $ZnCl_2$ from the measured cell potential. (4%)

   (e) the mean ionic activity coefficient of $ZnCl_2$ from the Debye-Hückel limiting law. (2%)

   (f) Given that $(\partial E_{cell}/\partial T)_p = -0.000452\ V\ K^{-1}$, calculate $\Delta_r H$ and $\Delta_r S$. (4%)

5. The dissociation vapor pressure of a salt at 370°C and 210 kPa but at 490°C it has risen to 560 kPa. For the dissociation reaction of $A_2B(s)$:

   $A_2B(s) \rightleftharpoons A_2(g) + B(g)$

   Assume that the vapor behaves as a perfect gas and that $\Delta H°$ and $\Delta S°$ are independent of temperature in the range given. calculate all at 430°C

   (a) the equilibrium constant. (5%)

   (b) the standard reaction Gibbs energy. (5%)

   (c) the standard enthalpy. (5%)

   (d) the standard entropy of dissociation. (5%)