

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

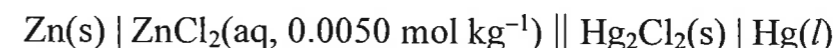
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注意事項：

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? ($\Delta_c H^\circ(C_{10}H_8, s, 298 K) = -5157 \text{ kJ mol}^{-1}$, $\Delta_c H^\circ(C_6H_5OH, l, 298 K) = -3054 \text{ kJ mol}^{-1}$, $H = 1.0079 \text{ g mol}^{-1}$, $C = 12.011 \text{ g mol}^{-1}$, $O = 15.9994 \text{ g mol}^{-1}$). (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:



The cell potential is +1.2272 V, $E^\circ(\text{Zn}^{2+}, \text{Zn}) = -0.7628 \text{ V}$, and $E^\circ(\text{Hg}_2\text{Cl}_2, \text{Hg}) = +0.2676 \text{ V}$. Determine

- (a) the Nernst equation for the cell. (2%)
- (b) the standard cell potential. (2%)
- (c) $\Delta_r G$, $\Delta_r G^\circ$, 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 $(\partial E_{\text{cell}}/\partial T)_p = -0.000452 \text{ V K}^{-1}$, 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
- $A_2B(s)$
- :



Assume that the vapor behaves as a perfect gas and that ΔH° and ΔS° 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%)