國立高雄應用科技大學
100 學年度碩士班招生考試
化學工程與材料工程系

准考證號碼□□□□□□□□□□ （考生必須填寫）

物理化學

試題　共 2 頁，第 1 頁

注意：a. 本試題共 5 題，每題 20 分，共 100 分。
b. 作答時不必抄題。
c. 考生作答前請詳閱答案卷之考生注意事項。

Given: R = 8.314 J $K^{-1}mol^{-1}$ = 0.08314 L bar $K^{-1}mol^{-1}$ = 0.08206 L atm $K^{-1}mol^{-1}$, 1 atm = 1.013 bar, 1 bar = 10^5 Pa, 1 kPa = 1000 Pa, 1 F = 96500 C mol^{-1}.

1. The vapor pressure of toluene is 2.67 kPa at 291.55 K and 8.00 kPa at 313.45 K. Calculate (a) the heat of vaporization and (b) the entropy of vaporization at 313.45 K. Assume that the heat of vaporization is independent of temperature.

2. A sealed evacuated vessel containing 5.96 mol m^{-3} of solid iodine is heated to 973 K. The experimentally determined pressure is 0.596 bar. Assuming ideal gas behavior, calculate the equilibrium constant *K* for $I_{2(g)} \leftrightarrow 2\ I_{(g)}$

3. An ideal gas expands isothermally at 298.15 K into an evacuated vessel so that the pressure drops from 10 to 1 bar; that is, it expands rapidly from a vessel of 0.0246 m^3 into a connecting vessel such that the total volume is 0.246 m^3. Calculate *q* (heat) per mole and *w* (work) per mole and each of the thermodynamic quantities, $\Delta\bar{G}$ (change in molar Gibbs energy), $\Delta\bar{A}$ (change in molar Helmholtz energy), and $\Delta\bar{S}$ (change in molar entropy).

$\bar{C}_P$ = 29.1 J $mol^{-1}K^{-1}$, $\bar{C}_V$ = 20.8 J $mol^{-1}K^{-1}$.

4. Consider a sequential irreversible first-order reaction $A \xrightarrow{k_1} B \xrightarrow{k_2} C$. Assume that only the reactant *A* is present when the reaction is initiated. (a) Derive equation for the concentration of *B* as function of time. (b) If $k_1 = 5\times10^4$ s^{-1} and $k_2 = 3\times10^4$ s^{-1}, determine the time at which the concentration of *B* is at a maximum.

5. The Edison cell can be expressed by
$Fe_{(s)}|FeO_{(s)}|KOH_{(aq)}|Ni_2O_{3(s)}|NiO_{(s)}$
and the half-cell reactions are as follows:
$Ni_2O_{3(s)} + H_2O_{(l)} + 2\ e^- \rightarrow 2\ NiO_{(s)} + 2\ OH^-_{(aq)}$ $\quad E^o = 0.40$ V
$FeO(s) + H_2O_{(l)} + 2\ e^- \rightarrow Fe_{(s)} + 2\ OH^-_{(aq)}$ $\quad E^o = -0.87$ V
(a) What are the overall cell reaction and cell potential?
(b) How much work can be obtained per kilogram of the active materials in the cell? Please take into account only the weight of reactants (active materials) in the cell reaction and neglect the cell housing, electrolyte, separator, and the current collector etc. Atomic weights of Ni, Fe, and O are 58.7, 55.85, and 16 g mol^{-1}, respectively.