國立高雄科技大學 109 學年度碩士班 招生考試 試題紙

系 所 別：化學工程與材料工程系碩士班　　組 別：丙組

考科代碼：1016　　考 科：熱力學

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注意事項：

1、各考科一律可使用本校提供之電子計算器，**考生不得使用自備計算器**，違者該科不予計分。

2、請於答案卷上規定之範圍作答，違者該題不予計分。

本試題共 5 題，總分為 100 分

Given: R = 8.314 J/K·mol = 0.08206 L·atm/K·mol

ln(2) = 0.6931, ln(3) =1.0986, ln(5) =1.6094, ln(7) =1.9459, ln(10) = 2.3026

1 bar = 10^5 Pa

1. Please express the following items in the mathematical form.
   (a) First Laws of Thermodynamics (4%)
   (b) Second Laws of Thermodynamics (4%)
   (c) Combination of the First and Second Laws of Thermodynamics (4%)
   (d) Third Laws of Thermodynamics (4%)
   (e) The van't Hoff equation (4%)
   (f) The Gibbs Phase Rule (4%)
   (g) The enthalpy of mixing for a regular solution (4%)

2. (a) Show that $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$ (6%)

   (b) Show that $C_p - C_v = [\left(\frac{\partial U}{\partial V}\right)_T + P]\left(\frac{\partial V}{\partial T}\right)_P$ (8%)

   (c) Derive that the general expression for the chemical potential of a component A (μ_A) in an ideal binary solution (A-B system) is given by $\mu_A = G_A + \mathrm{RT}\ln X_A = G + X_B \frac{dG}{dX_A}$,

   where G_A is the free energy of pure A, X_A is the mole fraction of A in solution, X_B is the mole fraction of B in solution, and R is the gas constant. (8%)

3. 9.85 g gold (Au) and 21.6 g silver (Ag) are mixed together to form an ideal single-phase solid solution. The molar mass of gold and silver are 197 g/mol and 108 g/mol, respectively.
(a) What are the mole fractions of gold (X_{Au}) and silver (X_{Ag}) ?(5%)
(b) What is the molar entropy of mixing (ΔS_{mix}) ?(5%)
(c) What is the total entropy of mixing?(5%)
(d) What is the change in the molar Gibbs free energy of mixing (ΔG_{mix}) at 773 K ?(5%)
(e) If we assume both the Gibbs free energy of gold and silver are zero, what will be the chemical potentials of gold (μ_{Au}) and silver (μ_{Ag}) at 773 K ?(5%)

4. The molar volume of copper is 8.0×10^{-6} m^3 for the liquid phase and 7.6×10^{-6} m^3 for the solid phase. The melting point of copper is 1085˚C. The latent heat of fusion of copper is 13.05 kJ/mol.
(a) Please express the Clapeyron equation, which is the relationship between the pressure and temperature for conditions of equilibrium between two condensed phases. (5%)
(b) What is the change in the equilibrium melting point of copper caused by a change of pressure of 10 kbar? (10%)

5. The composition region *x* and the composition at *y* are pointed out in the following free energy diagram. Please state which one is more stable and explain why. (10%)