國立高雄科技大學 114 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：乙組

考科代碼：1014　　考　科：物理化學

注意事項：

1、「可使用電子計算器之科目」及「電子計算器攜帶、使用規定」，依本校公告規定辦理，違者依本校「試場規則及違規處理辦法」規定扣分。

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，每題 20 分，共 100 分。

Given: $R = 8.314\ \text{J K}^{-1}\text{mol}^{-1} = 0.08314\ \text{L bar K}^{-1}\text{mol}^{-1} = 0.08206\ \text{L atm K}^{-1}\text{mol}^{-1}$, 1 bar $=10^5$ Pa

$\ln(2) = 0.6932$, $\ln(3) = 1.0986$, $\ln(5) = 1.6094$, $\ln(7) = 1.9459$, $\ln(10) = 2.3026$

$e^1 = 2.718$, $e^2 = 7.389$, $e^3 = 20.086$, $e^5 = 148.413$, $e^7 = 1096.633$, $e^{10} = 22026.466$

1. Calculate the reaction Gibbs energy ($\Delta_r G$) for producing $NO_2(g)$ at a pressure of 1 bar from $N_2O_4(g)$ at a pressure of 10 bar, at a temperature of 300 K. The equilibrium constant for the reaction $N_2O_4(g) = 2NO_2(g)$ is 0.2 at 300 K and the gas phase can be assumed to be ideal. (20%)

2. The vaporization of the liquid water is carried out reversibly at 100°C and 1.013 bar. The heat of vaporization is 40700 kJ mol^{-1}.
   (a) Calculate the change in molar entropy for the water. (10%)
   (b) What is the work done in vaporization (w per mole)? Assuming that the water vapor is an ideal gas and that the molar volume of the liquid water can be negligible. (10%)

3. For a specific compound, the vapor pressures (in Pa) for the solid compound (P_s) and liquid compound (P_l) as a function of temperature T (in K) are expressed as:

$$\ln P_s = 30 - \frac{6000}{T} \quad \text{and} \quad \ln P_l = 20 - \frac{3000}{T}$$

   (a) Calculate the temperature of the triple point. (10%)
   (b) Calculate the pressure of the triple point. (10%)

4. Consider an electrochemical cell $\mathbf{Zn(s)|Zn^{2+}(}\boldsymbol{a}\mathbf{ = 10^{-4})||Zn^{2+}(}\boldsymbol{a}\mathbf{ = 1)|Zn(s)}$ at 25°C, where $\boldsymbol{a}$ is activity, the vertical lines (|) represent phase boundaries, and || represents a salt bridge. Zn(s) denotes solid zinc. The standard half-cell potential at 25°C for $Zn^{2+}(a = 1) + 2e^- = Zn(s)$ is –0.763 V. Given: $F = 96485$ C mol^{-1}
   (a) What is the standard electromotive force of the cell ($E°$) at 25°C? (10%)
   (b) Calculate the electromotive force of the cell (E) at 25°C. (10%)

5. The temperature dependence of the rate constant (k) for a first-order elementary reaction obeys the Arrhenius equation and can be expressed as $\boldsymbol{k = A\,e^{-E_a/(RT)}}$, where A, E_a, R, and T are the pre-exponential factor, activation energy, gas constant, and absolute temperature, respectively.
   (a) If the half-life for this reaction is 10 s, calculate the rate constant. (10%)
   (b) If this reaction has a pre-exponential factor of 1×10^5 s^{-1} and an activation energy of 5×10^4 J mol^{-1}, calculate at what temperature the half-life of this reaction is 693.2 s? (10%)