國立臺灣科技大學 110 年度產業碩士專班招生(秋)試題

專 班 別：新穎薄膜暨電池材料

科　　目：物理化學

(總分為 100 分)　　不得使用計算器

物理化學

1. Please describe the items: (30 points)

(a) First law of thermodynamics　(b) State function　(c) Quasi-static process

(d) Adiabatic　(e) Spontaneous process　(f) Second law of thermodynamics

2. Prove that $P_iV_i^{\gamma}=P_fV_f^{\gamma}$ ($\gamma = C_{p,m}/C_{v,m}$) for the adiabatic reversible process, where P, V, $C_{p,m}$, and $C_{v,m}$ represent pressure, volume, heat capacity per mole at constant pressure, and heat capacity per mole at constant volume, respectively.

(20 points)

3. Please drive

(a) $\left(\frac{\partial H}{\partial S}\right)_P = T$ and $\left(\frac{\partial H}{\partial P}\right)_S = V$ (10 points)

(b) $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$ (10 points)

where H, V, T, P, and S represent enthalpy, volume, temperature, pressure, and entropy, respectively.

4. The average bond enthalpy of the O-H bond in water is defined as one-half of the enthalpy change for the reaction $H_2O_{(g)} \rightarrow 2H_{(g)} + O_{(g)}$. The formation enthalpies, ΔH°_f, for $H_{(g)}$ and $O_{(g)}$ are 218.0 and 249.2 kJ mol^{-1}, respectively, at 298.15 K, and ΔH°_f for $H_2O_{(g)}$ is -241.8 kJ mol^{-1} at the same temperature. Use this information to determine the average bond enthalpy of the O-H bond in water at 298.15 K. (10 points)

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5. n_0 moles of chlorine gas are placed in a reaction vessel, whose temperature can be varied over a wide range, so that molecular chlorine can partially dissociate to atomic chlorine. Assume the total pressure is P.

(a) Define the degree of dissociation as $\alpha = \delta_{eq} / n_0$, where $2\delta_{eq}$ is the number of moles of $Cl_{(g)}$ present at equilibrium, and n_0 represents the number of moles of $Cl_{2(g)}$ that would be present in the system if no dissociation occurred. Derive an expression for thermodynamic equilibrium constant (K_P) in terms of n_0, δ_{eq}, and P. (10 points)

(b) Derive an expression for α as a function of K_P and P. (10 points)