國立臺灣大學 106 學年度碩士班招生考試試題

1. If $dU = x^2ydx + 2xy^2dy$, please determine if U is a state function. (5%)

2. At 25 ^{0}C, one mol of an ideal gas is expanded reversibly and isothermally from 2 to 20 liters. Please calculate $\Delta U, \Delta H, \Delta S, \Delta F, \Delta G$. (15 %) [Hint: ln10 = 2.303]

3. Please derive

a) $dG = -SdT + VdP$ starting from the definition of G. (5%)

b) $-\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$ (5 %)

c) $dS = \frac{C_p}{T}dT - V\alpha dP$ (10 %)

4. Ten moles of water at 27 ^{0}C are mixed with ten moles of water at 67 ^{0}C. Any heat exchange with surroundings can be ignored. Please calculate the ΔS during the process. (10 %) [Hint: assuming water's $C_p = 75.3$ J K^{-1} mol^{-1} and independent of temperature]

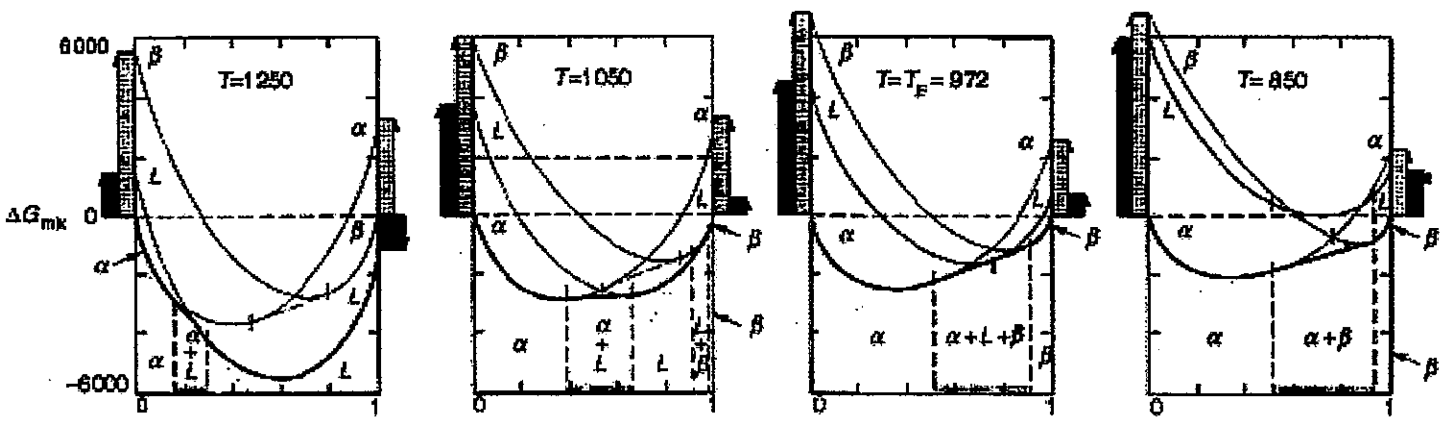
5. a) Please explain why chemical potential is only equal to partial molar Gibb free energy, not equal to partial molar inner energy or partial molar Helmholtz free energy? (5 %)

b) For a binary system, the Gibb-Duhem equation is $X_1 d\Delta\bar{G}_1 + X_2 d\Delta\bar{G}_2 = 0$. $\bar{G}_1$ and $\bar{G}_2$ are partial molar Gibbs energy. Please prove the following equation (10 %)

$$ln\gamma_1 = -\int_{X_2=0}^{X_2} \frac{X_2}{X_1}\frac{dln\gamma_2}{dX_2}dX_2 \qquad (\gamma\text{: activity coefficient})$$

6.Use the Clausius-Clapeyron equation to estimate the slope of the solid-liquid phase boundary of water. [Hint: Given the enthalpy of fusion: 6.008 kJ mol^{-1}, densities of ice at 0 °C: 0.916 g cm^{-3}, density of water at 0 °C: 0.999 g cm^{-3}] (10 %)

7. If the melting point of component 1 is 1400 K and component 2 is 1100 K. Please draw the potential phase diagram based on the G-X diagram shown as follows, (10 %)



8. Please explain what is difference between ideal solution and regular solution. Please compare the difference of their ΔS_{mix}, ΔH_{mix}, ΔG_{mix}, activity coefficient and phase diagram. (15 %)

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