國立臺灣科技大學
九十三學年度碩士班考試試題

系所組別：材料科技研究所
科　　目：熱力學

總 分：100 分，每題各佔 20 分。

1. Starting with the fundamental relationship for dH and using Maxwell's relationships, show that :

$$(\frac{\partial H}{\partial P})_T = V(1 - \alpha T)$$

where α is the isobaric thermal coefficient of expansion and V is the volume.

$$\alpha = \frac{1}{V}(\frac{\partial V}{\partial T})_P$$

2. Calculate the change in enthalpy of one mole of Co going from one atmosphere at 300 °C to 300 atmospheres at 350 °C. You may assume that α and V do not change with pressure.

$V_m = 6.9\ cm^3$ (molar volume)
$C_p = 24.1 + 14.3T - 0.88/T^2$ (joules/mole degree)
$\alpha = 0.27 \times 10^{-4}$ (degree)$^{-1}$

3. Metal A and metal B form a continuous solid solution across the binary system at 600 °C. The activity coefficient of A (γ_A) from $X_A = 0$ to $X_A = 0.3$ (X_A = mole fraction of A) is given by:

$$\ln \gamma_A = -0.8X_B^2 - 0.1$$

From the Gibbs-Duhem equation, derive an analytical expression for the activity coefficient of B from $X_B = 1.0$ to $X_B = 0.7$. Evaluate any integration constants.

4. The particles of a real gas occupy a finite volume and are surrounded by force fields which cause them to interact with one another. Van der Waals modified the the ideal gas law as van der Waals equation for the real gases, and succeeded in predicting the behavior of some of the real gases. Please write down the equation for van der Waals gases, and derive the critical condition, T_{cr}, V_{cr}, and P_{cr}, for the van der Waals gases.

5. Please derive the relationship between Henry's and Raoult's laws for a binary solution; i.e. in the range of composition over which the solute B obeys Henry's law, the solvent obeys Raoult's law.