

八十八學年度 工科系 系(所) 甲 組碩士班研究生招生考試

科目 普通熱力學 科號 3201 共 1 頁第 1 頁 *請在試卷【答案卷】內作答

Work all problems:

- In a van der Waals gas, does the volume affect the heat capacity? The internal energy? Provide a quantitative discussion. (15%)
- Consider a binary solid solution AB.
 - Derive the Gibbs-Duhem equation. (5%)
 - Prove that if the solute obeys Henry's law then the solvent obeys Raoult's law. (5%)
- Determine the maximum pressure of water vapor in wet hydrogen at 1 atm pressure in which chromium can be heated without oxidation occurring at 1500°K. Is the oxidation of Cr by water vapor exothermic or endothermic? For

$$\text{H}_2(\text{g}) + 1/2\text{O}_2(\text{g}) = \text{H}_2\text{O}(\text{g}) \quad G^\circ = -246000 + 54.8T \text{ joules}$$

$$2\text{Cr}(\text{s}) + 3/2\text{O}_2(\text{g}) = \text{Cr}_2\text{O}_3(\text{s}) \quad G^\circ = -1120300 + 260T \text{ joules} \quad (20\%)$$
- The activity coefficient of component A in a binary solution is known to be of the form $\exp C(1-2x+x^2)/T$, where C is a constant and x is the mole fraction of A.
 - Write out the partial molar free energy for component A. (5%)
 - Starting from (a), derive the partial molar free energy of component B. (5%)
 - Derive the molar Gibbs free energy of mixing, as well as the molar entropy and enthalpy change of mixing. (5%)
 - If mixing is exothermic, draw the vapor pressure ratio for A as a function of the composition. (5%)
- Derive the Clapeyron equation and Clausius-Clapeyron equation. (5%)
 - Draw a schematic phase diagram for H₂O and explain why skating on ice is possible. (5%)
 - Derive the Gibbs phase rule, $F=C-P+2$. (5%)
- Derive the following equation and fill the blank in the equation

$$\left(\frac{\partial H}{\partial V}\right)_T = -V^2 \left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial(\quad)}{\partial V}\right)_P \quad (10\%)$$

- State the First and also the Second Law of Thermodynamics. (5%)
 - Try to explain entropy from both classical thermodynamics and statistical mechanics. (5%)