國立臺灣科技大學 112 學年度碩士班招生試題

系所組別：材料科學與工程系碩士班丙組

科　　目：熱力學

(總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分)

1. (20%)
   (1) (10%) What is the Gibbs-Helmholtz equation, please express it.
   (2) (5%) Calculate the $\Delta H'_{mix}$ for the ideal gas mixture.
   (3) (5%) Calculate the $\Delta S'_{mix}$ for the ideal gas mixture.

2. (20%)
   Compare the work done in two processes:
   (1) (5%) One is reversible and isothermal process, where pressure change is from P1 to P2.
   (2) (10%) Another is adiabatic and reversible process, where the temperature change is from T1 to T2.
   (3) (5%) Draw the P-V diagram for these two processes. For both processes, the pressure change is from P_1 to P_2

3. (10%)
   Figure 1 shows the unary system phase diagram for the water.

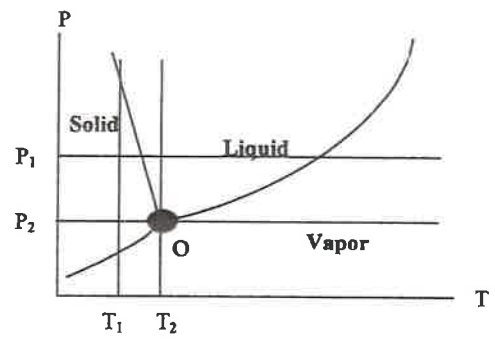

Fig. 1 the P-T diagram for water.

(each for 5%) Plot the G v.s P diagram at $T_1$and T_2, where point o is the triple point.

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4. **(30%)** The water steam reforming method is a general way to produce hydrogen, which the reaction is demonstrated by:

$$C_{(s)} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)}$$

Some thermodynamic properties at 298 K and the heat capacities at the constant pressure are given by:

	ΔH^0_{298}(J)	S^0_{298} (J K^{-1})	C_P (J mol^{-1} K^{-1})
$C_{(s)}$	---	5.73	10.05
$H_2O_{(g)}$	−241800	232.9	33.56
$CO_{(g)}$	−110500	197.5	29.11
$H_{2(g)}$	---	131.0	28.84

(1) **(15%)** Calculate the enthalpy change ($\Delta H^0_{rxn,298}$), the entropy change ($\Delta S^0_{rxn,298}$), and the Gibbs free energy change ($\Delta G^0_{rxn,298}$) of this reaction at 298 K.

(2) **(5%)** Express the function of the enthalpy change of the overall reaction ($\Delta H^0_{rxn,T}$) vs. temperature at constant pressure.

(3) **(5%)** Express the function of the entropy change of the overall reaction ($\Delta S^0_{rxn,T}$) vs. temperature at constant pressure.

(4) **(5%)** The reaction is non-spontaneous at 298 K. If the researcher only increases the reaction temperature, is there any possibility of making the reaction spontaneous based on the thermodynamic behavior? Explain it.

5. **(20%)** The Ag-Au is the ideal solution in the liquid state. Some thermodynamic properties are given by:

	Melting point T_m (K)	Enthalpy of fusion ΔH^0_m (kJ mol^{-1})	Molar volume of solid V^0 (cm^3 mol^{-1})	Density of solid ρ^0 (g cm^{-3})
Ag	1235	20.50	10.27	10.49
Au	1337	12.55	10.21	19.30

	Heat capacity of the constant pressure of the solid $C_{P(s)}$ (J K^{-1} mol^{-1})	Heat capacity of the constant pressure of the liquid $C_{P(l)}$ (J K^{-1} mol^{-1})
Ag	25.40	30.20
Au	25.42	29.54

A researcher uses the oven to melt one mole of solid silver at 1323 K. After the silver is totally transformed into the liquid, he drops one mole of solid gold at 298 K into the liquid silver. Assume that the oven temperature keeps constant throughout the process, and answer the following questions.

(1) **(5%)** Calculate the total enthalpy change of the sol during the solid gold is dissolved in the solution.

(2) **(5%)** Calculate the total entropy change of the solution during the solid gold is dissolved in the solution.

(3) **(5%)** Then, the Ag-Au solution is slowly cooled down to 298 K. What is the total volume of Ag-Au alloy if the alloy is an ideal solution?

(4) **(5%)** However, the molar excess volume of Ag-Au alloy is -0.5 cm^3 mol^{-1} at this molar ratio. Calculate the actual total volume and the density of Ag-Au alloy.