編號：　113　系所：資源工程學系乙組　　科目：熱力學

本試題是否可以使用計算機：☑可使用　，☐不可使用　（請命題老師勾選）

1. The heat will flow from the hot body to cold body if they contact. Please explain it using second law of thermodynamics. (5%)
2. Gibbs free energy and phase transformation

(2-1) What is the effect of pressure and temperature on Gibbs free energy (G)? (5%)

(2-2) Please plot the schematic diagram of the variation of Gibbs free energy with temperature and explain the phase transformation for liquid→ solid. (5%)

(2-3) Please explain the difference among unstable, metastable, and stable state using the schematic diagram of the variation of Gibbs free energy with position. (10%)

(2-4) Silica occurs in a number of different forms in the earth. Figure 1 is the fields of stability, in pressure-temperature space, of the polymorphs of silica. Please explain:

(2-4-1) Please derive the dP/dT for phase transformation of cristobalite→ tridymite using Clausius-Clapeyron equation. (10%)

(2-4-2) Cristobalite and tridymite both are high temperature phases. However, cristobalite and tridymite are often observed in room temperature. Please explain why? (5%)

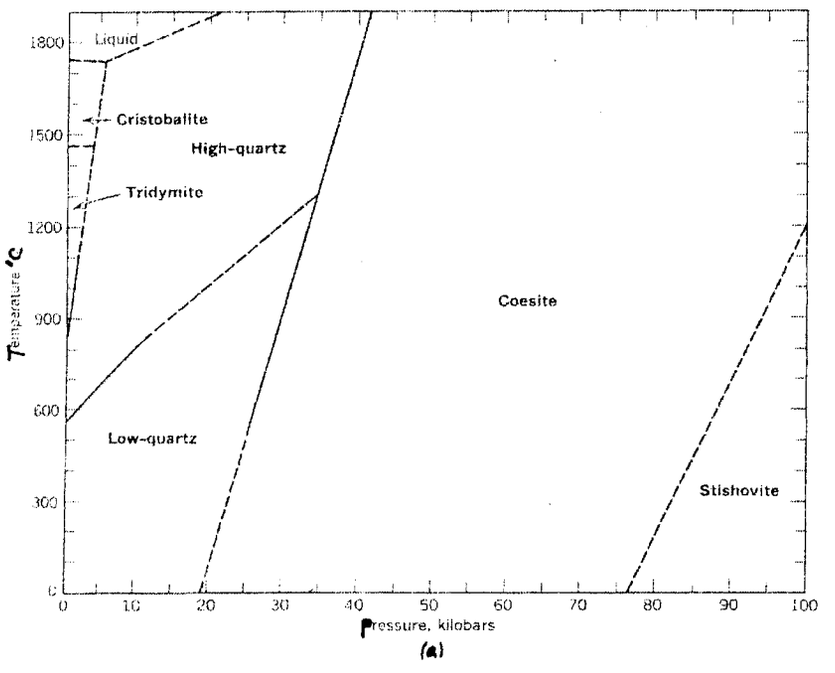

Fig.1

3. Please explain the below terms:

(3-1) Gibbs phase rule (5%)

(3-2) chemical potential (5%)

(3-3) Regular solution (5%)

(3-4) first law of thermodynamics (5%)

4. When an originally homogeneous high-temperature mineral, containing cations of considerably different size, is allowed to cool to low temperature, it always separates into two (or possibly more) distinct crystalline minerals. The above phenomenon is called exsolution. Please use the below equation and plot the curve of $\triangle G_{mixing}$-composition at high and low temperatures to explain the reason of the occurrence of exsolution .

$\triangle G_{mixing} = \triangle H_{mixing} - T\triangle S_{mixing}$ (10%)

5. Calculate the equilibrium constant and equilibrium partial pressure of oxygen for the reaction

$ZrO_2 = Zr + O_2$;

$\Delta G^o = 259940 + 4.33\ T \log T - 59.12\ T$ cal,

at 2000K. Also, predict the possibility of decomposing a pure zirconia crucible under a vacuum of 10^{-5} mm Hg (assuming that air contains 21% oxygen on volume basis) at that temperature. (the value of R = 1.987cal/deg/mole; 1 atm = 760 mmHg (10%))

6. Zinc melts at 420℃ and its standard entropy at 25℃ is 9.95 cal/deg/mol. Calculate the standard entropy of zinc at 750℃.

Given: heat of fusion of Zn at the melting point,

$\Delta H_f = 1.74$ kcal/mol.

$C_{p,\ solid\ Zn} = 5.35 + 2.40 \times 10^{-3}\ T$ cal/deg/mol.

$C_{p,\ liquid\ Zn} = 7.50$ cal/deg/mol. (10%)

7. Calculate the standard enthalpy and entropy changes at 25℃ for the reaction

$2\ Cu_{(s)} + 1/2\ O_{2(g)} = Cu_2O_{(s)}$;

$\Delta G^o = -40500 - 3.92\ T \log T + 29.5\ T$ cal. (10%)